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MECHANICAL ENGINEERING

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November 1928

It was a crime to burn coal in 1306

OVER 600 years ago King Edward the First issued a royal ban forbidding the use of coal as fuel. He considered the fumes and smoke from coal fires to be injurious to public health and well-being.

Today, the laws of economics oppose the burning of raw coal.

—for coal is more than mere fuel.

It is the most important basic product known to industry, and it should be so processed that each of its constituent elements may serve its most useful economic purpose.

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C. F. Hirshfeld, chief of the research department of the Detroit Edison Co., was graduated from the University of California in 1902 with the degree of B.S., receiving his M.M.E. from Cornell University in 1905. From 1903 to 1913 he served as instructor and professor in Sibley College of Cornell, and since that time has been holding his present position. He has also engaged in miscellaneous consulting engineering since 1900.

This Month's Cover gives us a picture of a bomber returning to Pope Field after its bombing mission over the Pee Dee River Bridge in North Carolina. It is used in connection with Brigadier-General Gillmore's article in this issue on "Military Aviation."

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MECHANICAL ENGINEERING

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The Perils and Profits of Research

By THOMAS STOCKHAM BAKER,[1] PITTSBURGH, PA.

I THINK we are all agreed that research in a broad sense is the chief hope for correcting some of the evils of this much-buffeted coal industry. In any program that is undertaken it is essential that the work be concentrated in a few centers. Much is to be gained through the cooperation of a considerable group of workers. It is greatly to be desired that a group of coal-mine owners should unite in maintaining laboratories at a certain number of universities whose work would be coordinated in such a way that there would be no overlapping or lost effort. The first essential is to get something started, and under the direction of well-trained and far-sighted men. If results could be shown I believe the scope of the studies could be enlarged rapidly and the support that is essential could be secured. Combined with this research program there should be offered opportunities for technical training. We are entering upon a new era of fuel technology, and the demand for men educated in the new science is going to be very general. This is an added reason why the universities should become the centers of coal research. While carrying on investigations they will be able to establish graduate courses in fuel technology.

THE United States possesses one-half of all the known coal deposits of the world. If we attempt to forecast the course that civilization is likely to follow, we shall be compelled to keep before us the significance of this magnificent and precious national asset. The nation that has the richest resources in power may or may not nurture the loftiest form of culture, but it can hardly fail to impose many of its ideas and ideals upon the rest of the world. It becomes a leader among nations because of its great store of energy. Our wealth of coal assures to our country a long continuance of its industrial greatness. It is the most cogent reason for believing that the citizens of the United States will for many generations live under conditions of material well-being. Prosperity and the refinements of life that are dependent upon wealth are impossible without ample and cheap power, and undoubtedly coal will serve as the chief source of energy until some revolutionary discovery makes obsolete the physical theories of today. Even though we may harness every stream and every watercourse in the whole country, the electricity thus gained will furnish but a fraction of the power that will be demanded by the generations that are to come.

It is not an accident that the United States is the nation in which the use of the machine has been pushed the farthest. It is the natural consequence of our superabundant supply of coal which gives us cheap power. The employment of machines to do the work of human hands will obviously gain a wider and wider ascendancy every year. This means more and more power. Modern life appears to be ruled by a kind of law—a law of the conservation of human energy—which requires that man shall do nothing that can be assigned to the machine. There is to be noted also a tendency to economize power and to produce it more economically. This law of the economy of energy has to do first with the saving of human labor and second with the production of this labor-saving substitute as economically as possible. Standardization with its accompanying development of mass production is a phase of the conservation of human resources.

We cannot estimate how much has been added to the world's available supply of energy by the process of rationalization, by diverting effort that has been expended upon unnecessary work into the main channels of energy to be utilized on the essential elements in our civilization.

In an address which I gave at the First International Conference on Bituminous Coal which was held in 1926 at the Carnegie Institute of Technology, I said: "Far-sighted men of affairs must perceive that something more than financial resources is necessary for commercial progress. Modern business demands two kind of capital, money and technical and scientific knowledge. A well-organized staff of research men can achieve results in a business way which cannot be secured merely by great credits."

Research a Curse and a Blessing

Research is a curse and a blessing. It is a curse to those individuals who do not employ it, and who are in competition with those who utilize scientific experience and technical skill. It is a blessing to those enterprises which owe their progress to the methods of the scientist and the skill of the investigator.

Every important step forward in technology is accomplished at the expense of some industry, while bringing profit to some other. The introduction of the electric light was a severe check, although short-lived, to the gas industry. The coming of the automobile dislocated a number of established business traditions. The discovery of the method of making alcohol from coal gave a blow to the wood-alcohol industry. Finally, science in teaching us how to make power economically has done a disservice, at least for the time being, to the coal-mine owner. He is baffled by what is taking place around him. He observes the curve which shows the consumption of power mounting rapidly. But his commodity, which must serve as the starting point of this rapidly swelling flood of machine-made energy, rises very slowly from year to year. Research to him has been anything but a benediction. Research has taught his customers literally how to make two blades of grass grow where only one grew before. His chief hope for the future must lie in adopting some of the methods of his customers. If with his present system he cannot secure an adequate return for his commodity, it behooves him

[1] President, Carnegie Institute of Technology.

Address at opening of the Second National Meeting of the A.S.M.E. Fuels Division, Cleveland, Ohio, September 17 to 20, 1928.

to call to his aid the engineers, and the men of science, who are, in a measure, responsible for his sad condition. The coal-mine owner is the key man in the industrial fabric. If by some turn of fate all the coal mines of the world should be shut down, our civilization would tumble about our ears. Life itself would be well-nigh impossible, and yet the coal producer is the creature of economic accidents which he can control only in a small degree.

Inroads Made in the Coal Industry by New Scientific and Engineering Developments

We see on every hand inroads being made in the coal industry by new engineering and scientific developments. The railroads, which taken as a group are the largest purchasers of coal, are moving more of their trains by electric power generated, in many instances, not from coal. The improved stokers mean a more economical use of fuel. We hear of the newly developed oil-electric locomotives, which are supplanting some of the coal-burning engines. These developments to which I have referred represent engineering skill, and they have been accomplished at the expense of the coal producer. It is extraordinary that so much thought, so much patient study, should have been given to the saving of a commodity which is cheaper in this country than in any other part of the world. Because it is so cheap, one might ask, Why be so thrifty? The coal producers may have thought their product too inexpensive to study, but their chief customers have taken an opposite point of view. The progress of fuel economy can be explained, at least partly, by the fact that the greatest consumers of coal are our great industrial organizations. It is they who practice efficiency in the highest degree. They have carried the farthest the conception of the integration of small plants into large units in their efforts to achieve good management. The improvements are the inevitable results of the progress of big business. We should not like to return to the era of the wasteful methods of the small power house, but we may well ask what the coal industry has done to combat or rather to match the engineering skill of the power industry. As the markets have been narrowed, it has not been possible to think of new ways of utilizing the output. To be sure, mine owners have been harassed by perplexing labor difficulties, by lack of cohesion within their own ranks, and by an overproduction which under the most favorable conditions would be difficult to dispose of. But the fact remains that research, which has injured their markets, can be employed to enlarge their opportunities. Their problem is to find new uses, new outlets, new employment for their commodity, and far-sighted men in this country and in Europe are already beginning to see that science can help in finding the answer. In Germany and in France they are uniting to support great laboratories where work of high scientific significance is being done, although the objective is to secure from coal a greater value than can be gained by selling it merely as fuel. A great many of the studies of these laboratories are still in the preliminary stages, and even if successful might not be adaptable to conditions in our country. The point of view from which the American research worker should study this subject might be different from that of his European colleague. We cannot foresee in just what respects science would cure the ills of the coal industry. We may be certain that it would not banish them as if by magic, but we may be confident that some of the apparently insurmountable difficulties will yield to the patience and hard work of the scientist.

Applications of Science to Industrial Problems

I have pointed out some of the effects of research upon the coal industry. We might also consider the subject of the application of science to industrial problems in a national sense, or even from an international point of view. I have already duly stated that the capital of a great industrial concern should be measured, not merely in terms of dollars, but also by the amount of managerial and scientific skill that is at the disposal of the company. So the wealth of a nation should be estimated not only according to the extent of its natural resources, but also by the ability of its scientific men to utilize these resources in the most useful and profitable manner. What has been achieved in this country in the efficient utilization of fuel is an element in the conservation of our resources of great value from a national point of view. In other words, if we can make one ton of coal do today the work that formerly required two tons, we have doubled our supply and thereby increased our national prosperity and our chances of prolonging our affluence.

If one were asked to give the reasons for the great wealth of the United States, the first reply would be, its abundance of raw materials. But we perceive that some nations with limited raw materials are making an effort through the aid of the scientist to overcome this handicap, and with some degree of success. The Great War compelled this quest for substitutes for essential commodities, or what were formerly regarded as essential.

This very significant development if continued further may give us in this country the uncanny feeling that we are not as rich as we thought. That is to say, if as a result of work done in the laboratory the chemist can produce a substance which will fulfil the purpose of one of our much-prized raw materials, we shall be forced to the conclusion that national wealth may be increased or diminished much faster by scientific skill than we had supposed. If, for example, those countries in Europe which have an abundance of coal but no petroleum should solve the problem of transmuting their coal into oil, what will be the effect upon our petroleum industry? The value of one of our great national assets is at once reduced. We have already witnessed the emancipation of Europe from the necessity of importing nitrates from Chile, as a result of the fixation of atmospheric nitrogen. It is an illustration of the reduction of Chile's wealth by chemists and engineers. We are already beginning to hear rumors of synthetic rubber. Certainly this dream of the research worker may not come true today, possibly not in the near future, but science does not allow itself to be discouraged by the seemingly impossible. It sets no limits to what it can accomplish. It turns waste products into valuable commodities. It plays strange pranks with the established industries while it creates new sources of wealth. Fortunately for the coal man, much of the new chemistry of synthetic compounds or substitute raw materials starts with coal.

Future Relations Between Universities and Industry

An important and far-reaching question presents itself in this connection: namely, what are to be the future relations between the universities and industry? A generation ago the activity of the scientist was restricted largely to his own laboratory. He had a conception of research which made him feel that science would suffer, might even be profaned, if he directed his talents and knowledge toward the solution of practical every-day problems. He conceived it to be his duty to add his contribution to the sum total of human knowledge. What he achieved was the common property of humanity. He concerned himself very little with the possibility of turning it to practical ends. In the period of, say, fifty years, and especially since 1914, there has been a complete revolution in the attitude of the scientist toward industry, so that today there is hardly an eminent physicist or chemist who does not have some sort of association with an industrial concern. The dread of a loss of dignity in turning his talents to practical ends has disappeared. The reverence for abstract science may be none the less genuine, and

his zeal for scientific advancement none the less real, but he has discovered that industry, or at least some industries, find a use for scientific abstractions, and that their most valuable helper may be the most advanced theorist. On the other hand, we observe that industry has usurped some of the functions that were formerly fulfilled only by the universities. A half-century ago there were no industrial plants in this country that maintained laboratories which did anything more than the most rudimentary testing. Today there are several dozen industrial laboratories which employ experts whom the universities would be proud to secure as members of their faculties. To those of us who recall the detachment of the universities and the indifference of business to science, the transformation is almost unbelievable. The universities have become, in a measure, centers of industrial progress, while some of the great manufacturing concerns have become centers for the pursuit of abstract science.

What of the future? Will industry become more theoretical and the universities more practical? One hesitates to hazard an answer. It is the duty of the university to occupy itself with the pursuit of knowledge for its own sake, to study those questions which may have little bearing on the problems of the present, but which must be settled if science is to advance. On the other hand, we cannot expect industry to be altruistic. It has discovered, or is at least in the process of discovering, that science "pays." But in the long run it will only support research so long as its results can be measured in dollars and cents. The universities have no such limitation. They should secure results, but their rewards must come through the knowledge that hidden secrets of nature have been disclosed, and they will achieve most for humanity, and possibly even for industry itself, the higher they set their ideal of achievement. We shall find that as time goes on more industries will establish their own laboratories. The accomplishments of such research enterprises, notably in the electrical and the chemical fields, have been so magnificent that they will prove an incentive to other manufacturers. However, I can foresee a time, not distant, when a far greater amount of industrial research will be carried on at the universities than is the case today. There are many reasons for this prophecy: the friendlier attitude to practical questions; the difficulty that is experienced by all business concerns except those that are carried on on a great scale, in maintaining extensive laboratories with a highly trained personnel; the lack of experience of most business men in dealing with scientific questions. Furthermore there are fundamental matters to be studied whose solution would be of great profit to all persons engaged in certain industries. These and other considerations lead one to believe that industry will turn more and more to the universities for help. If the authorities who administer the educational institutions are wise they will do what they can to meet these demands.

Research the Chief Hope for Correcting Some of the Evils of the Coal Industry

What bearing does this discussion have upon the coal industry? I think we are all agreed that research in a broad sense is the chief hope for correcting some of the evils of this much-buffeted business. There is hardly a coal company so large in this country that it would feel justified in setting up the kind of research organization that the conditions demand. But much could be accomplished if a group of companies would unite in supporting a common program of investigation.

In any program of research that is undertaken, it is essential that the work be concentrated in a few centers. Much is to be gained through the cooperation of a considerable group of workers. The allocation of problems piecemeal to a large number of laboratories makes it impossible to secure the benefits that are gained from the daily exchange of views between men who are working on problems that are closely allied. It is greatly to be desired that a group of coal-mine owners should unite in maintaining laboratories at a certain number of universities whose work would be coordinated in such a way that there would be no overlapping or lost effort. The first essential is to get something started, and under the direction of well-trained and far-sighted men. If results could be shown I believe the scope of the studies could be enlarged rapidly and the support that is essential could be secured. Combined with this research program there should be offered opportunities for technical training. We are entering upon a new era of fuel technology, and the demand for men educated in the new science is going to be very general. This is an added reason why the universities should become the centers of coal research. While carrying on investigations they will be able to establish graduate courses in fuel technology. Even if these research stations should be established we should find difficulty in securing the personnel that would be necessary. But a start must be made, and the sooner the better.

New Uses for Coal the Mine Owner's Chief Objective

What has been said on the subject of research implies that the coal-mine owner may become something more than a miner and a purveyor of fuel. Doubtless there are many questions of the technique of mining which should be studied, and whose study would yield profitable results. But the mine owner's chief objective must be to secure either a greater value from his product or to discover new uses for it. This appears to be the larger field for research, and the one that is most inviting. We are learning to believe that we must regard coal as a raw product just as much as merely material for burning. The question that the mine owner must decide is whether the raw material shall be worked up by himself or whether he will sell it to the manufacturer of chemical products or to the gas plant or to the power plant to be treated. It is hardly likely that any campaign of salesmanship or propaganda could be planned that would increase the sum total of coal to be consumed as fuel. The nation takes what it needs and no more. Certain companies may be able to expand their sales by skilful merchandising methods or through their special facilities for meeting the desires of their customers. But this will be accomplished at the expense of their competitors. It would then seem that the most likely way to increase the value of the coal industry would be to increase the value of coal, and it is here where the scientist can be of most help. In Pittsburgh we produce probably more steel than in any other city in the world. The cost of this commodity is comparatively low. But if it is fabricated it becomes more expensive in proportion to the amount of work that is expended on the process. Doubtless Pittsburgh would be a richer city if more of this manufacturing took place within her borders. In our district we also produce a great amount of coal, and in time it may be profitable for the mine owner to fabricate, so to speak, his product and thus add to its value and to the wealth of the community. This conception may at present seem rather hazardous and its carrying out must be tested not only by scientists but by practical men of affairs. In Europe the tendency of the mine owner to take on some of the functions of the manufacturer is going forward with considerable speed. With us the impulse in this direction is weaker because coal is cheaper. I realize there are many complications to be adjusted when the coal man departs from his traditional work of mining and selling: the finding of markets for the new commodities, the disarrangement of established methods, the risk of insufficiently tested new processes, the inertia of tradition; but the present conditions of the business seem to demand a radical departure. The coal man might feel encouraged to take some chances in this direction because other in-

dustries are finding it advantageous to purchase and to work coal mines. The chemical industry, the coke industry, the fixed-nitrogen industry, the gas industry, are drawing their raw materials from mines which they have acquired. It may appear impertinent for a university man to attempt to tell the members of the coal industry what they ought to do. This is not my intention. I can only point out what has been accomplished in other countries, and I can emphasize with great satisfaction the marvelously fruitful achievements of science in certain other industries.

Agencies Working to Promote Fuel Economy Ample and Effective

The purpose of this conference is much broader than that which is implied in this brief address. You are concerned just as much with fuel economy, and rightly so. In the long run it will be to the advantage of the coal man to know how far science is likely to go in limiting the need of his product. If we cannot help him we shall be doing him a service in revealing to him the worst that can happen to his business. The agencies working to promote fuel economy are already ample and effective. Most has been accomplished by the members of this great American Society of Mechanical Engineers, and it is a very hopeful and fortunate sign that they are now turning their attention also to those problems that are of immediate interest to the coal industry. There are few branches of business activity in our country that have utilized the resources of science so little as coal mining.

I might say that the starting point in the organization of the First International Conference on Bituminous Coal that was held at the Carnegie Institute of Technology in 1926 was the desire to be of service to the phase of business which is the foundation of the industrial greatness of the city of Pittsburgh. It is the same objective that is directing our efforts for the Coal Conference of next November. Many of the papers that will be presented may appear to have but a remote interest to the practical operator. They may seem theoretical, abstract. The processes that they describe may in some cases give the impression that they will be useful to future generations, but of little profit to the present. However, we believe that something will be accomplished if interest, or even curiosity, in scientific work is aroused. Something will be accomplished if a fairly complete picture can be given of all that is taking place in the field of fuel technology; if Americans who are engaged in the coal business can be informed concerning what is being done with their commodity in all parts of the world. With this in mind we have invited all nations where coal is mined or studied to send to Pittsburgh next November their representative fuel technologists. Already we have received acceptances from nineteen countries. About 125 papers will be presented, nearly three times as many as were offered at the Congress of 1926. Plans are being made to insure a thorough discussion of all the addresses. Emphasis will be laid on the economic aspects of new processes. Naturally the Conference will require a longer period than the first, and it is proposed to devote five or five and a half days to the meeting instead of three. If our first meeting accomplished something useful we are amply rewarded for the immense expenditure of time and effort. There can be no question of rivalry in promoting the advancement of science and the progress of American industries.

The Mechanical Engineer's Part in Increasing Railway Efficiency

By RALPH BUDD,[1] ST. PAUL. MINN.

RAILWAYS are not operated today as they were ten years ago, and the increased efficiency which marks the difference is quite largely the result of changes brought about by mechanical invention and the mechanical improvements which railway operating officials have adopted.

At the close of the World War great changes had to be met in the Northwest; particularly, the two greatest enterprises of this region—agriculture and the railroads—faced much the same problem. Both found themselves unable to sell their products on a price level even approximately comparable to the price level on which they had to buy their raw materials. Both had to find a way either of increasing the selling price or of reducing the cost of manufacture.

In the case of the railroads, wages and taxes had more than doubled, and these two items together made up two-thirds of the cost of operation. The cost of fuel, lumber, and other materials had gone up from 50 to 80 per cent, but freight rates had advanced only about 50 per cent in the United States and only 40 per cent in the Northwest. The plight of agriculture was much the same. Both of these industries were unable arbitrarily to advance selling prices, so they turned to ways and means for reducing the cost of production; and in the case of railroads, all they produced and all they had to sell was transportation.

[1] President, Great Northern Railway.

Address delivered at banquet, A.S.M.E. Summer Meeting, St. Paul-Minneapolis, Minn., August 27 to 30, 1928.

The New Era of Railway Development Entered Since the War

We have entered a new era of railroad development since the war—the era of the perfection of the existing plant, as distinguished from the earlier period which was one of expansion and which is now about to close. During the eight years since the roads were returned to private operation after the war, more capital has been expended on these railway properties than had ever been expended in any eight-year period of their entire history, yet the entire expenditure during these eight years, totaling six billion dollars, has not increased mileage perceptibly and has not resulted in putting into service any more locomotives or cars than were in service eight years ago. In so far as numbers are concerned the plant is about the same, but in other respects it is very different: larger and improved mechanical devices have replaced the small, obsolete units. It is as though the railroads had provided new clothes for a great giant who had entered their service. To take care of larger locomotives and larger cars, sidetracks have been lengthened, and terminals and shops moved and increased in size. The general result has been that today the railroads of this country are running fewer and larger trains, trains which go further between stops to change engines, and trains which therefore meet with less delay, spend less time on the road, and are more expeditiously handled in larger units. It has meant fewer but better terminals, fewer but better locomotives, fewer but longer passing tracks.

Greater Part of New Capital Invested in Mechanical Appliances

In the work of civil engineers, whose business during these eight years has been largely that of removing grades and curves so as to reduce the work of hauling trains, appliances which mechanical engineers have offered have been put into service. It is truly rather singular that out of the six billion dollars spent on railroads of the United States, a little more than half has been spent on contrivances termed "mechanical," while less than half has been spent by civil engineers in improving fixed property.

Another rather startling fact is that during the eight years since 1920 there has been added to the investment in railroad properties in this country one-third as much money as had been spent on those properties during the approximately one hundred years before 1920. One-quarter of the present total investment in railroad properties has been added since 1920, almost all of it having been spent in improving units of operation.

As a rule mechanics have not been used much in the upkeep of the fixed property, such as the tracks and bridges of railroads, yet one of the outstanding improvements which has made for efficiency during these recent years has been the introduction of power machinery, tools, and tractors.

Economy Resulting From Introduction of Section Motor Cars

Not many years ago all of the gang men on the tracks came to work on hand cars. Few jobs connected with a railroad so nearly approached drudgery as working one's way out and back on a hand car, up grade and against a hard wind. Men arrived at work tired and more or less discouraged. Hand cars have become virtually obsolete in the United States and men go to work on motor cars, speeding along at twelve or fifteen miles an hour, and arrive in a fraction of the time it formerly took, and in condition to go to work. Not only has this one improvement resulted in an enormous economy in the actual work of the trackmen, but its consequences have been far-reaching in several other directions. Immediately it meant that only half as many maintenance crews had to be kept, reducing the number of houses to take care of these men; but more important than anything else, it stopped the tendency in this country, especially in the Northwest, to use only foreign labor in trackwork. Now, on the Great Northern, we are employing 80 per cent or more of a splendid type of labor recruited very largely from the young men along our line, and work on the railroad has become preferred labor. These boys are acquiring valuable seniority and are fitting themselves for promotion in railroad work.

In the United States, in 1927, the freight moved per mile per employee per year amounted to 247,000 tons as compared with 202,000 tons in 1920, and on the Great Northern, in 1927, we moved an average of more than 300,000 tons per mile per employee per year as compared with 206,000 tons in 1920.

Just why should we be grateful to the men who have made available these mechanical contrivances? The reason is this: The Transportation Act of 1920, the law under which railways are operating, takes into account three principal parties: the public, which it is hoped will be provided with the most nearly perfect railway transportation at the lowest possible rates; the employees, who must be given safe employment under the best working conditions and at the highest possible wages; and the owners of the railway property, who, it is hoped, will receive a fair return on the value of the property used.

Transportation Rates Now the Lowest in History

I think it is fair to say that there has never been furnished, in the United States or any other country, transportation as adequate in amount, as high in quality, and, in comparison with other items in the cost of living, at as low a rate as that which is now being furnished. Railway employees have never had as good working conditions nor as high wages, and safety has never been at such a high level. It is a fact that today there is hardly a place in the world as safe as a railway passenger train.

The third party has not fared quite so well. The owners of the railway properties have not in any year received what the Interstate Commerce Commission has fixed as a fair return for the use of their properties. Sometimes it is said that the Transportation Act gives the carriers a guaranty. Of course it does not give any such guaranty. It expresses the affirmative principle that rates shall, if possible, be made so as to yield a fair return on the value of the property. If there had been a guaranty in the past eight years the Government would have been obliged to pay to the railroads of the United States about \$2,700,000,000 to make up the deficit. The Great Northern would have received fifty-five million, the difference between a fair return and what it actually earned.

It is perhaps true that no one of the parties interested under the Transportation Act has felt entirely satisfied, yet the railroad properties are in a fine physical condition, the employees and the public, I think, are better treated than ever before, and therefore in many respects the present Transportation Act, the law under which we are operating, has been very successful. But having spent six billion dollars—with somewhat more than three billion spent on the appliances of mechanical engineers and others—to bring about the results expected, the owners of these properties are now entitled to, and naturally will look to the future to receive, the fair return which they have prepared themselves to receive.

Transport

It may truthfully be said that the development of the potential wealth of any country depends mainly on the means of transport, both personal and industrial. The knowledge that there is efficient transport both by rail and for export by sea is the greatest incentive to the farmers to spend money in extensive cultivation with the certainty of a ready market for such production.

The comparison of travel today both by land and sea, with my early journeys in Europe nearly fifty years ago, emphasizes in my mind how much we are indebted to the engineer in the way of personal safety and comfort and also prompt delivery of our products. The comfort and safety of modern travel is to my mind one of the glories of modern civilization.

Railway transport has made great progress in all measures affecting personal safety and the efficient carrying of our various products. The railway engineers have every reason to be proud of their management of the complex organization represented by the great railway systems all over the world. We personally are much safer traveling in an express train than we are crossing the streets of a great city, and I think we may justly be satisfied by the fact that in no country do the railways afford more comfortable or more rapid traveling facilities than in our own. The railway engineer has still some very interesting problems to face. Heavier and more powerful locomotives are the natural outcome of the demand for heavier freight trains. The civil engineer of a railway company cannot deal with this problem without strengthening bridges and improving the condition of the permanent way. All these developments involve large capital expenditure, which it is not convenient for many railway companies to undertake at the present time.—Sir William Ellis in his Presidential Address before the British Association, Section G., on September 7, 1928.

Ohio Falls Hydro Development at Louisville Meets Unusual High-Water Conditions

To Prevent the Building From Floating Away at Times of Flood It Must Overcome an Upward Pressure of 7,500,000 Pounds on the Scroll-Case Roof and Turbine Cover Plate

By HARRISON G. ROBY,[1] CHICAGO, ILL.

The building of a hydroelectric plant at the Falls of the Ohio became possible with the Federal water-power enactment, followed by the growth of a market which could use this secondary power, and aided by the design of a propeller type of turbine. Conditions of unusual rise in times of river flood were met with a design of structure that could not be floated from its foundations. This station, with a capacity of 80,000 kw., is believed to be the largest in which the units can be operated from a supervisory switchboard, and which automatically shuts down when trouble develops on the line.

THE development of hydro power at the Falls of the Ohio, opposite Louisville, Ky., had been considered for many years, but it did not become economically feasible until recently, when several causes joined to make the proposition practicable, these being:

1 Passage of the Federal Water-Power Act, making it possible for the United States Government to join with private parties in a navigation and power project

2 Growth of a market which could absorb a large amount of secondary power, the only kind generated at this station

3 Development of the propeller type of turbine runner. Its advantages of operating under widely varying heads and increased speed effected a saving in cost per kilowatt-hour of energy generated, a saving that was needed to bring the cost of hydro power down to that of steam power.

The conditions that had to be met in the design of the plant were unusual. While the maximum operating head is 37 ft., the expected tailwater rise is 65 ft., and care had to be taken to prevent the structure from floating from its foundations during maximum high water. A drainage system was required which leads all leakage to a sump at one end of the plant, with automatic pumps and an emergency pump with vertical shaft, the motor being 36 ft. above the pump.

The capacity of the plant is 80,000 kw. This is believed to be the largest station in which the units can be started or shut down from a supervisory board and which automatically goes out of service whenever trouble develops.

The Ohio River has been used for navigation since the earliest settlers began crossing the Appalachian Mountains into the Northwest Territory and Kentucky. It was the main highway into this vast region before the days of wagon roads and railroads. The slope of the river is very little, averaging for low-water conditions about 0.7 ft. per mile from Pittsburgh to Cincinnati and 0.33 ft. per mile from Cincinnati to where it joins the Mississippi at Cairo, Ill.

At Louisville the river passes over a limestone outcrop, and the rapids have a fall of about 25 ft. in two miles. It was dangerous for boats bound downstream to shoot the rapids, and upbound traffic could not climb them except at very high river stages. It was therefore necessary to break bulk at this place and to carry the cargoes around the falls. A private company was organized in 1825 which built the first canal and lock in 1831. The United States Government later took over this improvement, increased the size of the lock, and built a dam across the river, increasing the lift of the lock to 29 ft.

As the railroad systems developed, the Ohio River was used less as a means of transportation. Recently, however, the Government has undertaken to encourage water-borne traffic. In 1910 a project for the improvement of the Ohio from Pittsburgh to Cairo was adopted, which includes the construction of a series of 51 dams, with locks for low-water conditions and navigable passes during high water. Each dam backs the water to the foot of the dam above it, so that for the entire length of the river slack-water navigation will be provided with a minimum draft of 9 ft. The cost of this improvement will be about $110,000,000, and it will be completed by the fall of 1929.

Ohio Falls Project

At Louisville this project contemplated a new dam 8 ft. higher than the original one, which would back the water about 80 miles and at low water would require a lift of 37 ft. at the lock. This difference in water level at once attracted attention to this site as a water-power possibility. During the World War the United States Government considered this site, along with Muscle Shoals and others, for the purpose of developing power to be used in making war materials. The intermittent nature of the power that would be obtained made the development less attractive than others which would yield a considerable amount of firm power, and the War Department went no further than the preliminary study.

In 1920 the Federal Power Act was passed, and in 1925 the Louisville Hydro-Electric Company, a subsidiary of the Louisville Gas and Electric Company, was granted a license to construct the power station. The company agreed to pay to the Government an annual rental on the cost of a dam built for both navigation and power in excess of the estimated cost of a dam for navigation only. The contract for the construction of the dam was awarded by the United States district engineer to the Byllesby Engineering and Management Corporation, which also was the engineer and constructor of the power station for the Louisville Gas and Electric Company.

At the time the license was granted the company was instructed to work with the district engineer in determining the location and type of dam best fitted for the combined navigation and power project, and the joint study of the situation resulted in the adoption of a rather unusual location. The dam runs from the outstream end of the power house up the middle of the river for nearly 7000 ft. and then turns and abuts on the Indiana shore, its total length being 8650 ft. The question that naturally is raised is why such a long line was selected for the dam site. It appears as though unnecessary expense had been incurred by building on this line instead of shortening the dam by crossing

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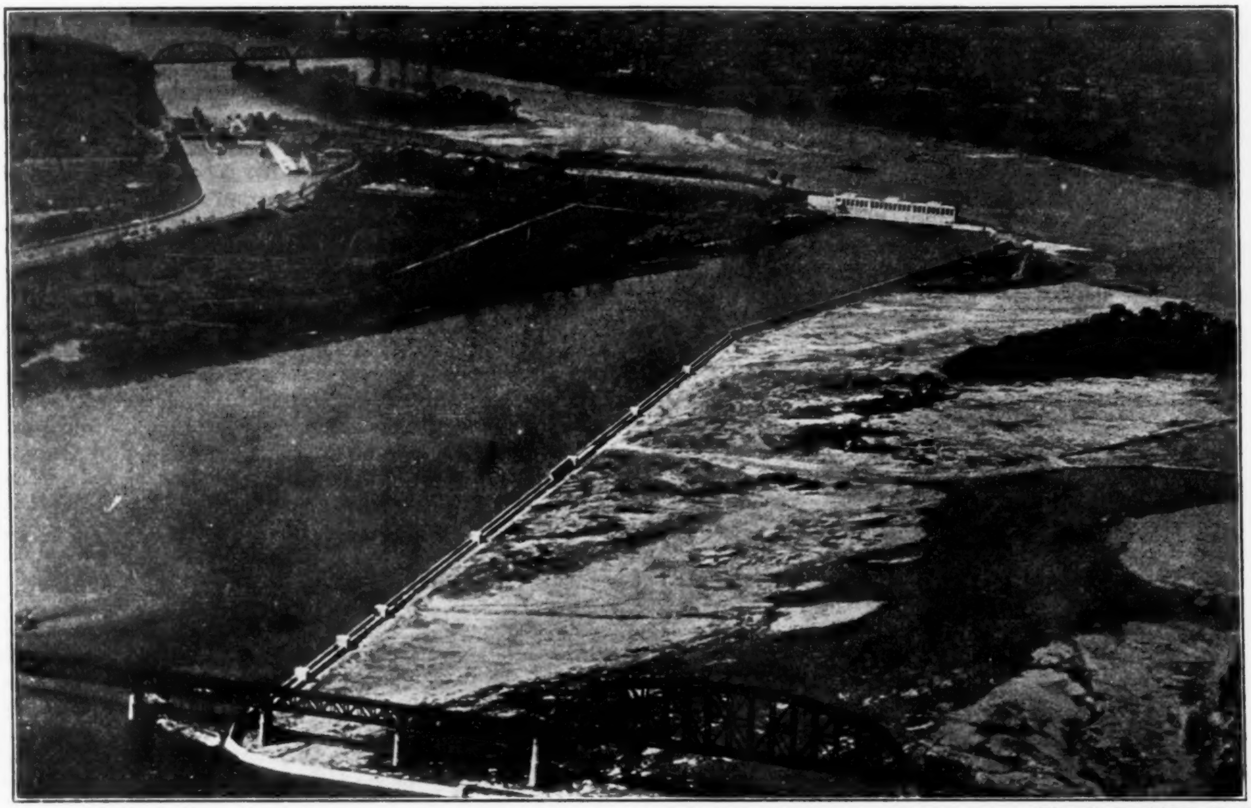


Photo by Caufield P. Shook

FIG. 1 AIRPLANE VIEW OF POWER PLANT AT FALLS OF THE OHIO OPPOSITE LOUISVILLE, SHOWING UNUSUAL LENGTH OF DAM RUNNING UP THROUGH CENTER OF RIVER

to the Indiana shore farther downstream. The site was chosen for the reason that on the Indiana side the river bottom has been eroded in a deep gorge not more than 800 to 1000 ft. wide, with rock elevation over 35 ft. lower than the ledge on which the dam was built. The flow that had to be passed during construction was about 100,000 c.f.s., and thus it would have been necessary to build the cofferdam about 45 ft. high and to place the cribs in very swift water. Estimates of the cost of the dam were made all the way from a line straight across the river from the end of the power house to locations abutting on the Indiana shore at points even higher than the one selected. It was found that the cost of cofferdams, plus rock and concrete work, was the minimum for the site chosen, with incidentally a very great decrease in the hazards encountered in the cofferdam work.

At the lower end of the dam are two bear-trap gates, each 91 ft. wide and 15 ft. deep and with a discharge capacity of 15,000 c.f.s. Their purpose is to give quick response to sudden increases in flow and thus make it possible to hold the pool level constant. In addition 3600 ft. of the dam is made of the Boulé type, with a movable crest 10 ft. high, and 860 ft. is made of the Chanoine wicket type, with wickets 14 ft. high, the latter section being used for the navigable pass. The reason for such a large flood-discharge capacity in a dam which is nevertheless expected to be overtopped at high-stage flows is to make it possible to maintain the upper-pool level and the use of the lock until the lower pool has risen to nearly the same level. Then when the river increases in flow beyond the capacity of the gates, the upper-pool level rises, the lock is put out of commission, the navigation pass is opened, and traffic takes the route through the dam and down the channel of the river.

EFFECTIVE HEAD AND WATER LEVELS

A serious adverse condition that required consideration in the design of the plant and the selection of the hydraulic equipment was the extremely wide variation in water levels. The flow varies from a minimum of about 5000 c.f.s. to a maximum of nearly 800,000 c.f.s. Because of a narrow section of river and high banks some miles below Louisville, there is a rise in tailwater level amounting to about 1 ft. for every 10,000 c.f.s. increase in flow at moderate discharges. With the eight 13,500-hp. units installed, the output increases as the flow increases from minimum up to the water capacity of the plant, about 31,000 c.f.s., the head remaining constant at 37 ft. When a discharge slightly greater than this amount takes place, the tailwater begins to rise, cutting down the available head and reducing the output. This decrease in head and output continues until the water wheels can no longer maintain speed and the plant must be shut down. There are about 40 days in the average water year when the flow will exceed 300,000 c.f.s. and no power will be generated. At the time the plant goes out of service the head has been reduced to $7^1/_2$ ft.

Further increase in flow causes the tailwater to continue to rise until it is within about 2 ft. of the headwater level. By that time all of the discharge capacity of the dam has been brought into use and control of the upper-pool level has been lost. When the discharge continues to increase, there takes place a rise in both the headwater and tailwater, the tailwater slowly overtaking the headwater, until at maximum flow, about 800,000 c.f.s., the tailwater has risen a total of 65 ft., the headwater about 28 ft., and the difference in level has been reduced to a few tenths of a foot.

This unusually great rise in water level during flood made it

necessary of course to build the substructure very high. The bottom of the draft-tube foundations is 31 ft. below normal lower-pool level; the pool level rises 65 ft., and 4 ft. was added to allow for future floods of greater magnitude than those recorded. The total height of the substructure is therefore just 100 ft. The superstructure adds 53 ft., making a total height of 153 ft. In order to save height in the superstructure the generators were placed on a floor 16 ft. below possible high water, a reinforced-concrete wall with no outlets being carried around the generator room.

Owing to the height to which the river rises at maximum flood, the design of the building required consideration of a problem that rarely comes up in power-house work, and that is flotation. When the river is at maximum flood, the upward pressure on the roof of the scroll case and on the turbine cover plate for each unit 58 ft. wide will be about 7,500,000 lb. Care had to be taken that the weight of the structure above the scroll-case roof plus the weight of the installed equipment was sufficient to over-

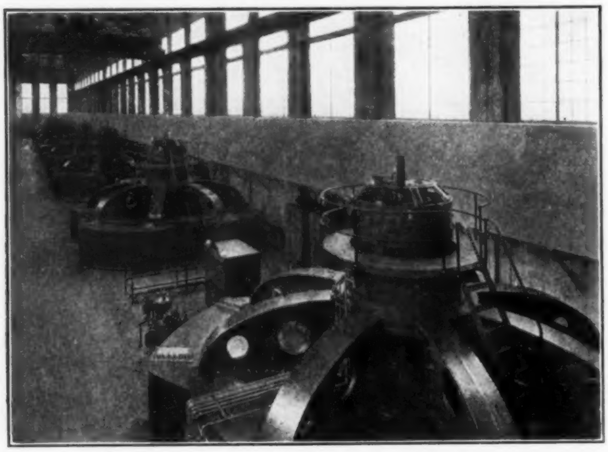


FIG. 2 POWER HOUSE AT FALLS OF THE OHIO, SHOWING THE EIGHT 13,500-HP. UNITS IN SEALED CONCRETE ROOM WITH FLOOR 16 FT. BELOW POSSIBLE HIGH WATER

come the upward pressure and to prevent the building from floating away. This limited the extent to which coring out of the concrete could be practiced.

PROPELLER TYPE OF RUNNER A FEATURE

It is quite probable that the development of Ohio Falls could not have been undertaken at this time if the water-wheel designers had not brought out the propeller type of runner a short time before the study of this scheme was authorized. It is also probably true that no large-size development ever made in this country could benefit to a greater degree than does this one by the adoption of the new type of wheel. As is evident from the intermittent nature of the power obtained, the energy generated at this station is all secondary; and the cost per kilowatt-hour had to be kept down to a low figure to compete with the cost of secondary steam-generated energy, amounting to little more than the cost of the fuel burned in generating those kilowatt-hours. The adoption of the propeller type of runner had much to do with keeping the cost within economical limits. There are two advantages inherent in the propeller type of runner. These are its ability to operate under a wider variation of head than the standard Francis type, and its higher speeds under the same head.

In most installations the rise in tailwater is only a comparatively small percentage of the total head, and while it may reduce the output slightly it does not have a serious effect on the wheel as regards keeping up to speed. At Ohio Falls the variations in tailwater are extreme and are subject to a change of as much as 10.5 ft. in 24 hr. While the maximum head is 37 ft., the average head is only 28 ft. for the period during which the plant can operate. With the old style of runner a reduction of head to 16 or 17 ft. would have put the plant out of service. With the type adopted the plant has operated with a head of 7.5 ft., and units have been started up, brought up to speed, synchronized, and put under load when the head was only 8 ft.

The increase in output owing to the adoption of the propeller type as compared to the Francis type is estimated to be about 10 per cent, and all of this increase can readily find a market because it is in the zone of low plant output, less than the off-peak system demand. In addition to this increase in kilowatt-hours output, owing to ability to operate under a wider variation in head, the propeller type of wheel, because of its greater speed, makes possible a comparatively large saving in cost of equipment and power-house structure.

The Ohio Falls wheels have a speed of 100 r.p.m., and some of the other makers were willing to guarantee satisfactory operation of units having speeds of 106 and 112 r.p.m. In comparison, the Keokuk units, which at 30 ft. have about the same output as do the Ohio Falls units at that head, run at a speed of 58 r.p.m. The main effect of this increase in speed is a reduction in the size of the generators. The Keokuk generators, which are 124-pole machines, are 34 ft. in diameter. The Ohio Falls generators, with 72 poles, have diameters of 26 ft. There is therefore a large saving in the cost of generators. The propeller-type runner, consisting of a small number of blades or vanes with no outside band, is much simpler to pattern and cast than the Francis type, and there is therefore a considerable saving in hydraulic equipment also. The decreased cost of power-house structure is brought about by the decrease in transverse overall dimensions. It is to be noted that if 8 ft. in width had to be added to the width of 48 ft., this additional width would extend from the foundation to the roof, a total vertical distance of over 150 ft. The length of the building that would be affected is 508 ft. The saving in cost owing to the adoption of the high-speed runner is estimated to be 10 per cent. The total reduction in cost per kilowatt-hour is therefore about 20 per cent, which was a very material factor in determining the feasibility of this project.

On account of the high specific speed of the runners it is necessary to keep the draft head low and to locate the wheels as near tailwater level as possible, to prevent cavitation. As built, the center of the runner is only about $3^1/_2$ ft. above low tailwater, and as this level remains low only about 80 days in the ordinary water year, the wheels operate submerged a large part of the time. As stated, the generators are placed on a floor 16 ft. below possible flood level. Even with the depression of the generator foundations, the main shafts running from the bottom of the runners to the exciters above the generators are 67 ft. long. It required very nice work on the part of the hydraulic and electrical erectors to get the shafts in true vertical alignment. The thrust bearings are of the spring type, designed for a combined hydraulic thrust and dead load of 500,000 lb. and are located above the generators and below the direct-coupled exciters.

There are four guide or steady bearings per unit, one directly below the thrust bearing, one below the rotor of the generator, one made of lignum vitae and water lubricated, immediately above the runner, and the fourth one on the extension part of the shaft, between the cover plate of the turbine and the base of the generator.

There are two independent central oil systems, one for all bearings except the water-lubricated lignum-vitae bearings above the turbine runners, and one for the operation of the

governor servomotors. In both systems the oil is taken from tank cars by gravity into reservoir tanks at the land end of the building, and is then filtered and distributed by piping system to the different parts of the equipment of each unit which require oil. For the bearings the continuous or "trickle" system was adopted. The oil is circulated continuously at the rate of 8 gal. per min., or 1 gal. per unit, thus insuring a high quality at all times. In addition the usual arrangement of a small filter and pump mounted alongside each unit is retained, so that in case of interruption to the central supply a unit can continue to operate for several months with the oil in its individual reservoir. For the governor supply any unit can be drained off to the central filter system and replaced by new oil by gravity within a very few minutes.

Automatic and Remote Control

The units are provided with "full automatic" control. Pressing a push button, either at the small control panel near the unit or at the supervisory board located at the center of the building, begins the sequence of steps required to start up a unit and synchronize it. A steam plant is proposed for future construction, adjacent to the hydro plant. The supervisory control board will then be placed in a location central to both plants, and the chief operator at this board will have direct control of the units of both plants. The sequence of events in starting a unit is as follows:

1 Governor oil-pressure valve is opened by governor pick-up solenoid, and oil is admitted into the governor actuator

2 Air-operated brakes at base of generator rotor are released

3 Latch holding turbine gates closed during shutdown is lifted, allowing the gates to open slowly

4 Unit starts to revolve, increasing in speed as the governor permits the gates to open further; flyball motor is put on station bus

5 Field is excited

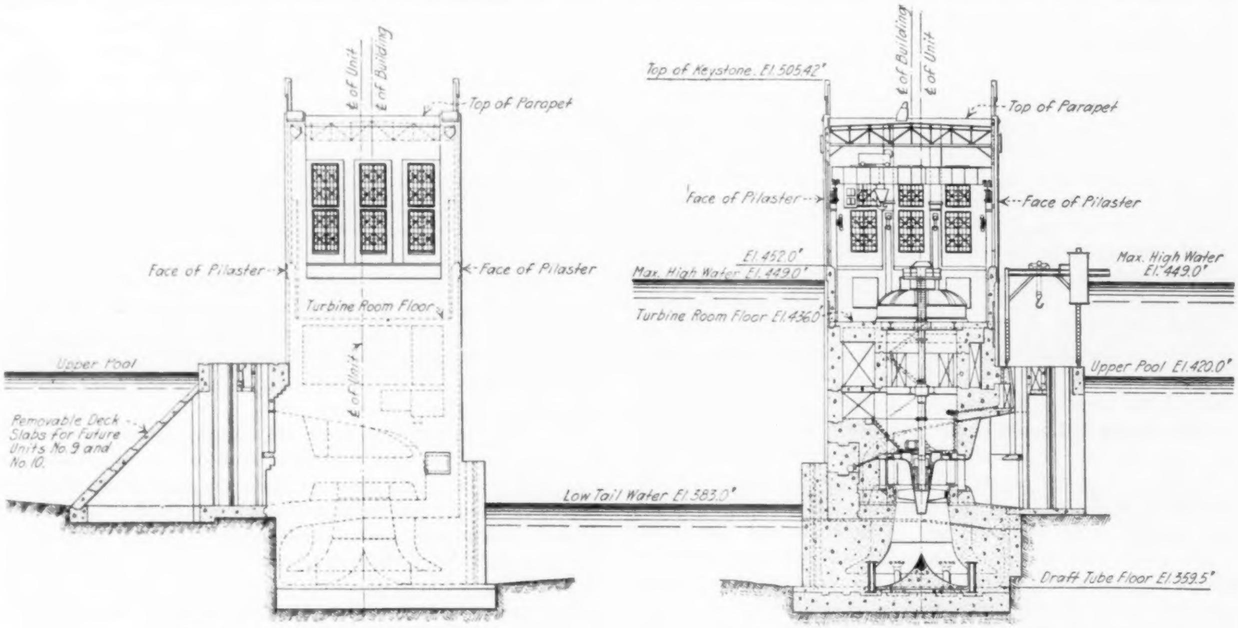
6 As unit approaches synchronous speed, flyball motor is switched to generator; when the machine is accelerating slowly enough into the system frequency and is practically in step, the speed-matching device permits the circuit breaker to close, and the machine goes on the line

7 Amount of load is slowly increased up to the amount previously fixed in setting the load-limiting device.

The reverse procedure is followed in shutting a unit down. It is automatically taken out of service for any one of the following reasons:

1 Overheating of governor or bearings
2 Loss of generator field
3 Overvoltage
4 Overload
5 Overspeed.

Another feature that is new in water-power plant design is the use of an enclosed system of ventilation for the generators. A diaphragm is placed about 6 ft. below the generator base. The air, after being expelled by a generator, passes through water-cooled radiators, thence through ducts into the enclosed space below the generator, from whence it is drawn again into and through the machine. The water for the coolers is taken from the headrace at the center of each unit and is pumped up into the coolers, from which it is discharged and returned to headwater.



END ELEVATION UNIT No. 8 TRANSVERSE SECTION OF UNIT

Fig. 3 Design of Plant to Overcome Possibility of Floating Structure From Foundations During Excessively High Water—Eight Units Have Total Capacity of 80,000 Kw.

With the increase in efficiency in steam plants and the resulting reduction in cost per kilowatt-hour, the cost of hydro developments must be cut if they are going to be developed. In the case of the Ohio Falls project a considerable saving has been made possible, first, by the cooperation of the United States Government in building the dam, under terms now made available for projects of this nature by the Federal Power Act, and second, by the use of the propeller-type, high-speed runner. With the increase in demand a larger percentage of the possible output of hydro plants can be utilized in the market served. Lower first cost and greater output will in many cases bring border-line hydro projects into the region of economic feasibility.

Discussion

FORREST NAGLER[2] and W. M. White[3] submitted a discussion by telegraph in which they said that the author's description of the Louisville plant was exceptionally complete and particularly interesting because of the novel features incorporated in the design and emphasized by the magnitude of the scale on which they had been carried out. This was particularly significant in connection with the size of the units, the extreme variation in head, the adoption of full automatic control, the radical departure from conventional switchboard arrangement, and the handling of the ventilating air for the generators. It was felt that one additional comment on the turbine structure might be in order. The term "propeller runner," likewise "high-speed runner," "axial-flow runner," or "suction runner," had come into general use as indicating a type of runner more or less completely described by the particular name adopted. A wide variation in capacities and speeds and consequently specific speed was under the control of the designer within any of these descriptive names. The latter feature was, unfortunately, very difficult to define except mathematically, and that characteristic did not lend itself to incorporation in the name of the runner type. This had resulted in calling all of this general type of runner by some such specific name as "propeller type." That in itself would not be harmful, were it not for the fact that the type under some significant name was applied freely by certain engineers to all heads for which they could get a manufacturer to build it. Such procedure was contrary to proved practice in reaction wheels, and was equally open to criticism in this newer field.

These high-speed runners had first been brought out and rapidly developed for specific speeds from 150 upward, using the English rating system. The initial field had been for low heads, that was, under 25 ft. Such runners could have a small number of blades and a relatively small blade area—frequently less than one-half the area of the passage. As the heads became higher, as for example at Louisville, the suction effect depended upon at low heads became a lesser proportion of the total, and larger areas and lower speeds became an immediate requirement. The Louisville units had a specific speed of about 127 figured from the normal rating of 13,500 hp., 37 ft. head, and 100 r.p.m., which was about midway between the highest-speed reaction wheels of the older types and the average of the newer high-speed runners. In other words, it was an intermediate type, and while it possessed the rimless axial-flow shape characteristics of ship propellers, it would actually make a very poor ship propeller. An inspection during the previous week, after approximately one year's operation, had indicated excellent condition of runner, discharge ring, and all the surrounding parts, no appreciable deterioration of any kind being in evidence.

Not the least unusual feature of this plant, as affecting turbine design, was found in the fact that all openings in the turbine cover were frequently subjected to exceptionally high back pressure. This involved problems in design, particularly as regarded minimizing and getting rid of leakage not usual in hydro plants.

The performance of this plant during the past year was extremely gratifying and was a most excellent tribute to the engineers of the Byllesby organization responsible for its design.

The author, in reply to queries by Prof. Charles F. Shoop, chairman of the session, regarding the load for which the wheel was designed and what its efficiency was at the lower head of $7^1/_2$ ft., said that the variation of head from 37 ft. down was fairly well known when the wheel was designed. At that time the Allis-Chalmers Company had given a certain output for a 12-ft. head, and had varied that so that it might be possible to get some power at a 10-ft. head. The output was more important than the efficiency in this case, because for something like 75 days in the ordinary year there was more water than the plant could utilize, and what was particularly desired was large capacity. As to the efficiency, the guaranty was around 87 per cent for a head in the neighborhood of 28 ft., which was the average operating head through the average year. From that it dropped down as the head went down, until around 12 ft. no guaranty was made as to either output or efficiency.

[2] Hydraulic Engineer, Allis-Chalmers Mfg. Co., Milwaukee, Wis. Life Mem. A.S.M.E.

[3] Chief Engineer, Allis-Chalmers Mfg. Co., Milwaukee, Wis. Mem. A.S.M.E.

Future Developments in Machine Tools

WHEN machine-tool design and construction is advancing as rapidly as at present, it is not unnatural to ask, What of the future? What notable development may we expect? The first, no doubt, is the increase of feed and speed as the result of further progress in the art of making cutting tools. We may expect, too, with reasonable certainty to see an extension of heavy grinding, and the disappearance of the countershaft is foreshadowed by the extension of individual motor drives. But there are, so far, no indications that any totally new form of machine tool, a new method of removing metal, if we except autogenous cutting, is almost in sight. It seems that for years to come machine tools will retain substantially the same forms which they have now. But details will change and we have heard it said that in ten years' time the hydraulic feed will be very widely employed. Its development is a subject of great interest. The hydraulic operation of cutting tools, lathes particularly, is no new thing. It will be recalled that during the war one shell factory—that of Spencers, of Melksham—was fitted throughout with hydraulically manipulated tools, and did wonders in the speed of output.

We cannot indeed yet foresee the day when hydraulic feed will be so accurate that screw cutting without dies may be done by it, but ordinary feeds in which absolute accuracy of movement is not essential are now attained in several machines of different types. The advantages are considerable. In the first position we may place cost. Machine tools are nowadays such expensive appliances and so many are required that anything that will reduce the expenditure upon them is of great moment. The hydraulic machine with its absence of trains of gear and shafting is obviously easier and cheaper to produce than the normal pattern, and though, at first, cost may remain high, we anticipate that, for the same service, it will in time fall below that of mechanically operated tools. Then, again, it is probable that the cost of upkeep will be lower, so that the user will gain in both directions. But the absence of mechanism has another notable advantage. The danger of accidental breakage is reduced. It is quite easy to arrange in a hydraulically operated machine that no more than a specified maximum pressure can be exerted; if it is passed, then a loaded valve may lift and relieve the pressure. The same characteristic is employed where work has to be carried up to a definite point—as, for example, a collar on a shaft. Again, the manipulation of the machine is reduced to the greatest simplicity. The operator has no more to do than handle a few little knobs, which control the valves, to get any variation of feed that he may desire, and the range of feeds has no steps; it may be taken from zero to the greatest by perfectly even gradations. Finally, hydraulic operations holds out the possibility of attaining the greatest feeds which the development of new steels may permit without the introduction of costly mechanism, and in all probability with the expenditure of less power.—*The Engineer* (London), Sept. 21, 1928, p. 319.

FIG. 1 WEST-SIDE MILLING DISTRICT, MINNEAPOLIS, MINN.

Power in the Flour Mills at Minneapolis

BY MAURICE DWIGHT BELL,[1] MINNEAPOLIS, MINN.

THE city of Minneapolis owes its location and its existence to the power development of St. Anthony Falls. Except for the water power, there would have been no city other than St. Paul, which had been established many years before and which had many natural advantages as a trading point and as the head of river navigation, which for years was the only means of access to the Northwest Territory. The Falls of St. Anthony were discovered in 1680 by Father Louis Hennepin, who named them after his patron saint. They were accurately described in a report by Jonathan Carver in 1766, but no use was made of the power for another 50 years. In 1823 the colonel in charge of Fort Snelling, at the junction of the Minnesota and the Mississippi Rivers, constructed a small mill to grind wheat into flour for the soldiers' use. This was near the Washburn A Mill on the west side of the river below Sixth Avenue South, and for 26 years this was the only flour mill in the state.

Flour was first ground in a commercial way in 1853, on the east side of the river in the village of St. Anthony, later incorporated into the new city of Minneapolis. In 1856 companies were organized to develop the water power operating under the name of the St. Anthony Falls Water Power Company on the east side of the river and the Minneapolis Mill Company on the west side. The formation at Minneapolis lent itself to easy power development. The ledge of blue limestone, varying from 15 to 20 ft. in thickness, is underlaid by sand rock. The method of tunneling which was employed was developed in 1858, which made it possible to place the water wheels in convenient locations on the mill sites, cutting down through the limestone for the wheel pits and thence conducting the water through the tailraces cut in the sandstone and back to the river below the falls. Many of the original tunnels are still in use.

The oldest mill on the falls still in existence is the Cataract Mill on the west side, built in 1859. Development was rapid, until in recent years these mills reached a combined daily capacity of 90,000 bbl. of flour in 24 hours. Minneapolis continues to be the largest producer of flour of any city in the world. From 1865 to 1874 destruction of the falls was averted only by such emergency measures as the construction of a concrete dike under the limestone ledge above the fall and improvement of the apron spillway. Disastrous accidents in tunneling above the falls had collapsed a portion of the limestone ledge.

Sawmills were among the first to make use of the water power, but as the timber was cut off, the power passed exclusively into

[1] General Superintendent, Washburn Crosby Company.

Contributed by the St. Paul Local Committee and presented at the Summer Meeting, St. Paul-Minneapolis, Minn., August 27 to 30, 1928, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, 29 West 39th Street, New York, N. Y.

the control of flour-mill owners. In recent years a portion of this power has been used for general power purposes, and the excess flood water during spring and fall is used in a hydroelectric generation station on Hennepin Island, supplying part of the power required by the Twin City Rapid Transit Company.

Power Fortunately Was Near the Wheat

Here was provided the most important water power in the Middle West, in a growing community, near virgin wheat fields, and with favorable freight rates to the East, a combination that resulted in the development of a great flour-mill center. With the growth of the flour mills came a highly specialized departmental development giving opportunity for engineering and particularly in the field of power development and application. Much pioneer work was done which later carried its benefits to the flour-milling industry throughout the country. Cheap and reliable power has always been of first concern in flour milling. Water

Fig. 2 Grain-Conveyor Belt Used in Grain Elevators and For Shipping Wheat to Flour Mills

power was the first to meet these requirements, and then came steam, and in recent years electric power. This paper will consider these three phases in the order of their development at Minneapolis.

The water-power installation made use of the best experience at Lowell and Holyoke, Mass. The wheels were usually of the vertical-turbine type installed near the tailrace water level, with short submerged steel draft tubes. The vertical water-wheel shaft was connected with the main lineshaft of the mill by means of bevel gears, one of each pair having mortised teeth with maple cogs. Many of these gear drives are in everyday use at the present time. In recent years many of these vertical wheels have been equipped with the Kingsbury type of vertical step bearing in place of the old submerged wooden blocks.

These wheels have ranged in size from 200 and 300 hp. up to 2500 hp. in a unit. In several instances two wheels were installed in one pit, and by means of two pairs of gears, one right-hand and the other left-hand, drove the same mill shaft. In general each water wheel provided power for a separate flour-mill unit. The usual operating efficiency was well above 80 per cent delivered to the mill lineshaft. The head at first developed was only 22 ft., but with increasing demand for the water the tailraces were lowered and the pond level raised, until today the head utilized varies from 45 to 48 ft., depending on the location and on the stage of water.

The leases are in terms of "mill-powers," 75 hp. theoretically, with a water-wheel efficiency of 80 per cent giving 60 hp. on the mill shaft. A mill-power requires 14 c.f.s. at 46 ft. head. Flour-mill leases total 268 mill-powers, but when excess water is available the mills use several times this amount. The present rate for excess water is $6 per mill-power per day of 24 hours, equivalent to $0.0056 per kilowatt-hour if translated into electrical terms. As this is below the average cost of coal in Minneapolis for power developed by steam, it is an attractive rate.

Because the original ownership of the mills and the water-power companies was identical, about one-third of these leases are free and carry no rental. The others are for varying amounts, but the average is low, and therefore the use of water power at Minneapolis represents a very distinct saving to the extent to which it is available. The use of water power has been largely determined by the many small water-power leases which still govern. The leases taken out in the early days assigned certain mill-powers to specified wheel pits. The order in which these leases were issued determined the priority claims on water available in the river. The water-power company estimates the flow and apportions it according to the priority right of the wheels that the mill owners wish to run. The leases last issued are cut off first.

Complications Come From Old Leases

Another complication arises from the issue of the original leases for 16 hours' use only. Modern flour mills run 24 hours per day or not at all. As a means of compensating the mill owners who shared the expense of lowering the tailraces and improving the water power, certain of these old leases were made available for 24 hours' use and others for 24 hours' use only when water was sufficient. All of these conditions affect the distribution of power and the availability to mill owners. These leases run from $^1/_2$ mill-power up to 14 mill-power in a lease. They are not transferable, and the rental therefor if not paid becomes a first lien on the mill site.

The future development of this power may possibly be worked out electrically on some plan by which distribution will be effected with recognition of the present priorities. The flow of the Mississippi River at Minneapolis is subject to wide variation through the year and from one year to another. Some improvement has been made in regulation of the flow by the Government's providing storage reservoirs at the headwaters of the river. The fluctuation is from a minimum of 1000 c.f.s. to flood water of 60,000 c.f.s. It requires approximately 6000 c.f.s. to provide water for all leases, but during the winter months the average is about one-half of this.

Steam power came into use when millers of vision stopped thinking that their business was necessarily seasonal in character and that it was reasonable or necessary to shut down when water was no longer available. Steam power was installed first as secondary power to carry over the periods of low water, but later on, as demands increased and water power was not available or economical to develop for short periods, steam grew into wider use. The year 1883 was a low-water year and a period of heavy demand for flour. The C. C. Washburn Mills were equipped the next year with two Wright engines of 1400 hp. each and the Pillsbury A Mill was equipped with an Allis compound engine purchased at the Louisville Exposition. These engines were the forerunners of modern steam plants. In 1893 a triple-expansion engine of 1200 hp. was purchased by the Washburn Mills and installed in the A Mill. This engine was built by the Schichau Werke in Germany and won first prize at the Chicago World's Fair, where it generated electricity for lighting the exposition grounds.

The first steam turbine was installed in the mills at Minne-

apolis in 1907 to generate electric power for grain handling in a new reinforced-concrete elevator, one of the first two or three to be thus constructed in the United States. Thereafter the electrical development was rapid, and additional turbines were installed and motors were placed in new mills instead of reciprocating engines. The engines used at Minneapolis have been the best available at the time in sizes from 800 hp. to 3000 hp. each, Corliss, uniflow, or poppet-valve types. Some combination installations have been made exhausting into low-pressure mains for supplying steam for heating or drying. The practice generally has been to run condensing, favoring the barometric condenser because of the convenience of installation at the river level, with a clear drop of over 45 ft. to the tailrace and an unlimited supply of cold water available without pumping equipment. These engines have been placed adjacent to the mill lineshaft, to which power was transmitted by leather belts or by rope.

Steam Turbines and New Types of Boilers Added

Steam turbines have been installed for generating electric power in sizes from 300 to 2000 kw., and in one instance connected direct to the mill lineshaft by means of reduction gears. In the

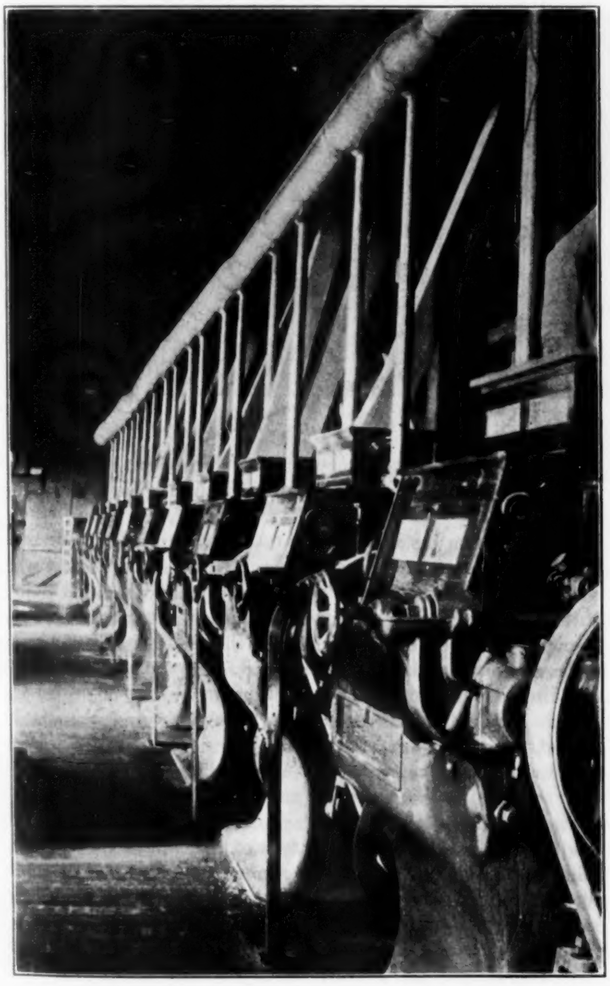


Fig. 3 Roller Mills on Grinding Floor

boiler room new types of boilers have been added as developments showed them to be economical. Steam pressures have been raised, new types of stokers installed, and proper auxiliaries provided to insure continuous operation. Feedwater heaters, softeners, economizers, superheaters, and similar equipment have been utilized to such a degree as local load factors justified, bearing in mind that a large portion of the steam capacity was required for only four or five months in the year.

With coal consumption reaching several hundred tons per day

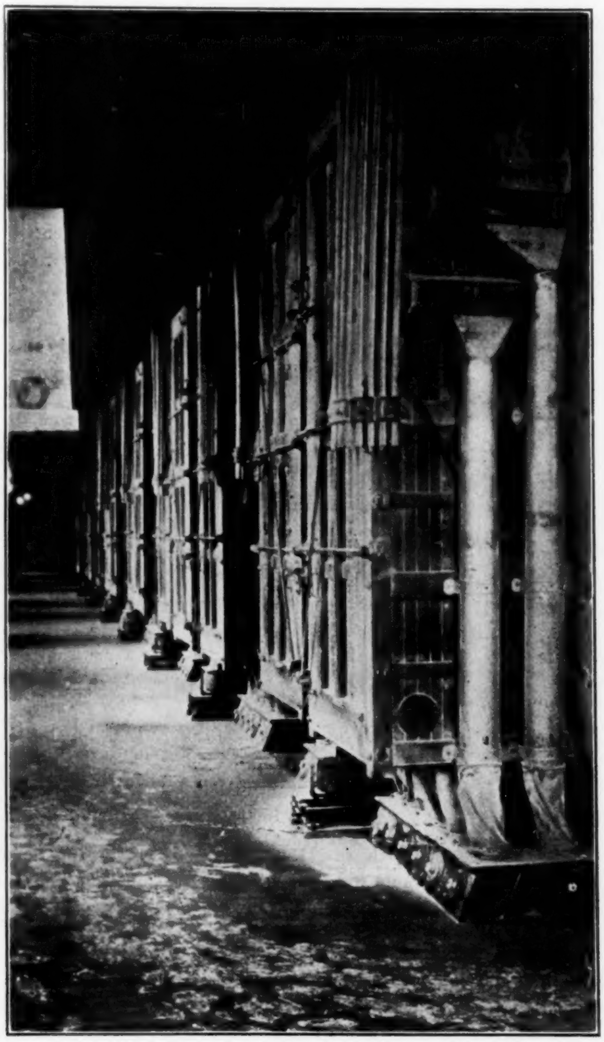


Fig. 4 Self-Balancing Sifters Used in Modern Mills

in individual mill boiler rooms, it was essential that economical operation be maintained, and instruments for checking results and insuring combustion at the highest point have been installed. In recent years, as central stations have sought to obtain flour-mill contracts, favorable comment has been occasioned by the records of flour-mill power cost.

Electricity came on the field after most of the big milling companies had installed highly efficient steam plants to meet all requirements. The first development was therefore for secondary use only, supplementing the water power and the steam power. Later it come into another field for primary power for the new mills. In other fields this situation has been reversed, as at Buffalo, where the electrical development was earlier, and in the territory adjacent to Kansas City and the southwest. Direct current had been used successfully for lighting in the flour mills at Minneapolis as early as 1884, but it had no particular advantage for

power, and the cost of producing electrical energy in the early days was prohibitive. When electricity was generated only by reciprocating engines it was cheaper to use the steam engines as a direct application. With the introduction of the steam turbine operating under higher economies and with improvement in generator and motor design, the situation was changed. The number of electrically driven mills is increasing because of the convenience in applying power electrically.

The first use of electric power in the flour mills at Minneapolis was with electricity generated in their own steam plants. In 1910 electric power was made available for flour-mill use from hydroelectric plants within a radius of 50 miles from Minneapolis, transmitted at what was then a phenomenal voltage of 60,000 volts. The first contracts were for the purchase of surplus or off-peak power. Later on with increased capacity in central-station steam plants, contracts were executed for considerable blocks of electric power for regular use, one of these being for a fixed demand of 4000 kw.

The application of electric power to flour-mill work and elevators has given new possibilities and convenience to mill design, but numerous problems have turned up and have required modification in design of equipment and control apparatus. As late as 1908 the lack of available information as to flour-mill requirements rendered one of the largest motor manufacturers unable to guarantee that a slip-ring motor of 1000 hp. would have starting torque sufficient to start a 3500-bbl. flour-mill load. The experimental work has been done largely by flour-mill engineers.

Increasing reliability has encouraged the use of electricity. The flour-mill process is continuous and any interruption is costly. Equipment had to be developed to eliminate trouble from lightning and surges, and relays to sectionalize trouble. The present extensive use of electric power at Minneapolis is directly due to the admirable improvements that have been made in this particular.

Transmission of power from the motor to the mill lineshaft has been by belt, rope, chains, gears, and frequently by direct connection. Where flexible couplings are required, modern development provides several of satisfactory design. Magnetic or mechanical clutches have been used successfully with synchronous motors in flour-mill drives.

Motors Adopted as They Were Developed

The development of the alternating-current motor of the squirrel-cage type was a great advantage to flour mills, particularly in their grain-handling departments, where safety was of first importance. Squirrel-cage motors have been applied to a wide variety of individual small group drives where heavy starting torque is not required. By far the largest number of these motors would be in sizes under 50 hp., but installations have been made up to 350 hp. where the transformer capacity was adequate to take care of the starting current. Wound-rotor motors have been used, either of the internal-resistance type or with slip rings and brushes for heavy starting load. These are in sizes from 100 hp. to 1000 hp., and frequently they are of the slow-speed type direct-connected to the main lineshaft of the mill. Synchronous motors have been installed where power-factor correction was important or, for higher efficiency, where clutches could be used to pick up the load.

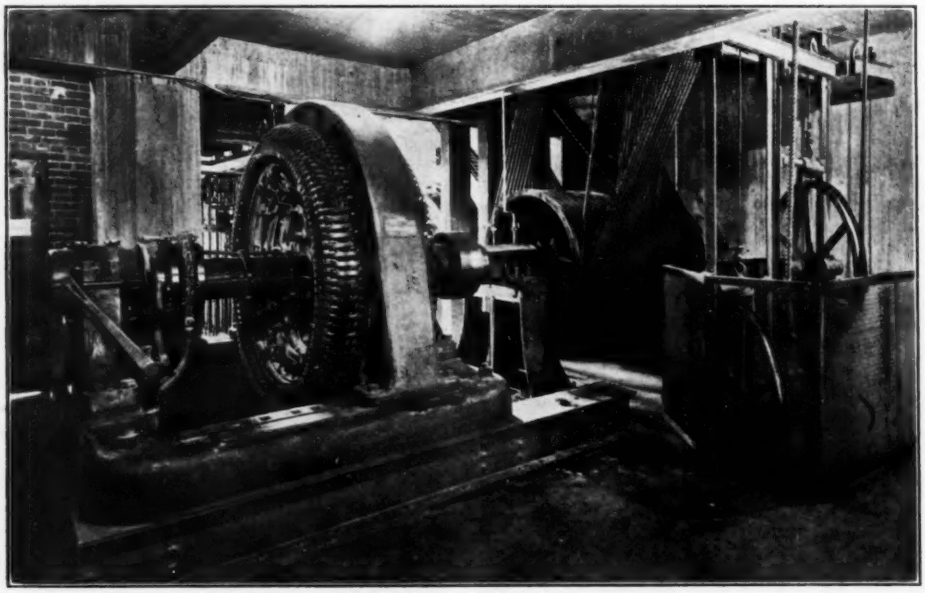


FIG. 5 1000-HP. INDUCTION MOTOR AND ROPE DRIVE FOR 3500-BBL. FLOUR MILL

An interesting installation was made in a group of flour mills having a number of small water-power leases, at mills that were occasionally idle when steam power was required at other points of the system. The leases stipulate that the water must be used in specified wheel pits, but do not refer to the power. This company replaced its water wheels with new and improved horizontal units and direct-connected them to synchronous motors of proper capacity. When these mills are idle and the water would otherwise be wasted, the wheels are now run and the machines generate electric power that is transmitted to a central distributing point and from there fed to any mill requiring additional power. At other times when these mills are running and the available water is not adequate to develop the power required, these synchronous machines are used as motors drawing current from the system to make up the deficit. Instead of paying an annual rental for water not used, they are now showing a satisfactory saving on their total power cost more than sufficient to justify the increased investment.

Another interesting electrical development in a flour mill is an automatic electric generating plant. The water power at the mill is supplemented by a hydroelectric station three miles away on another stream controlled by the mill owner. This station is entirely automatic in control, starting and stopping without the supervision of any local operator, as the mill load requires.

Transformer stations are required for power purchased at higher voltages. These have all been of the "indoor" type at Minneapolis and placed as near the mill load as convenient. Power is purchased at 13,200 volts, or 2300 to 4000 volts if for direct application to larger units. The smaller motors have all been 440-volt, 60-cycle, because of the greater convenience afforded in distribution.

The control and distribution of electric power have required special study to adapt it to milling requirements and particularly to make it dustproof. Automatic control has been provided frequently for starting equipment, and also interconnected tripping circuits for shutdown in case of an emergency. Flour-mill practice has contributed to new standards as expressed in the National Electrical Code and in local ordinances. High credit has been given for the type of installations by the flour mills and grain elevators. Safety has been receiving increasing consideration in all flour-mill work in recent years, and in these power applications adequate guards have been provided and operating has been relieved greatly from the distressing burden of accidents.

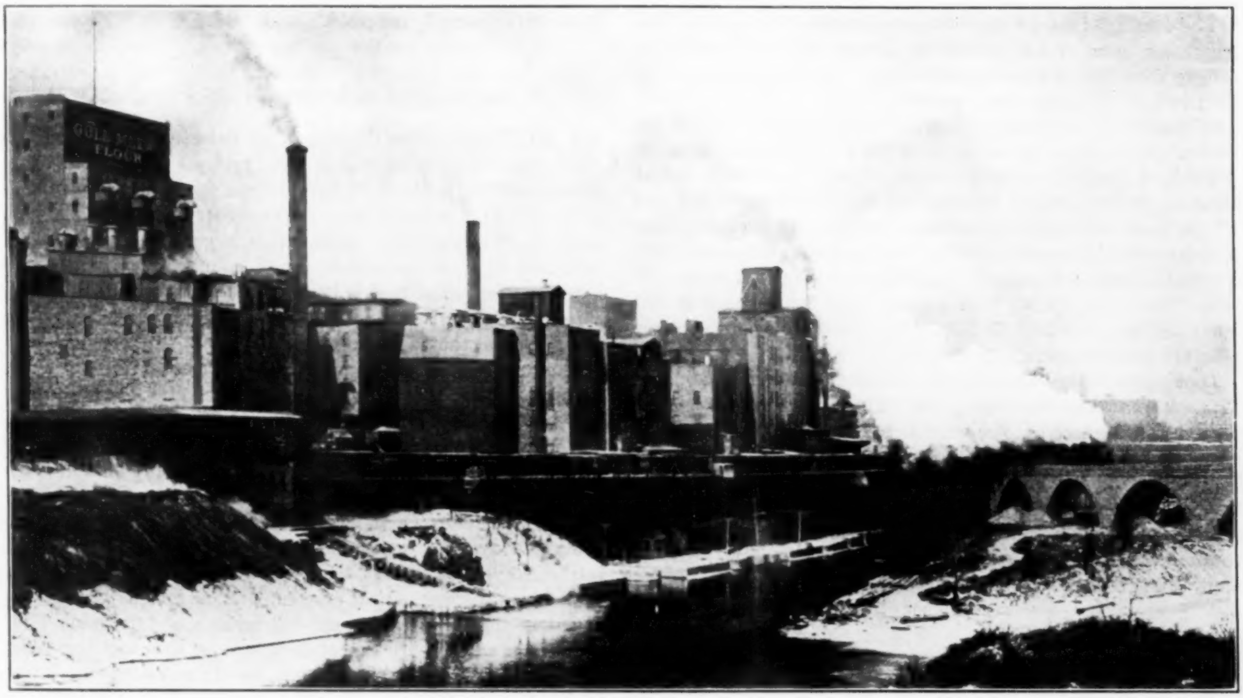


Fig. 6 View of Milling District

The power contracts entered into by the flour mills with the local central-station company have indirectly benefited the city at large. The flour-mill loads are attractive, being practically steady for 24 hours, six days in the week, and with the growth of generating capacity and larger and more economical units, power has been purchased at favorable rates. In times of emergency the mill companies have been able to drop off their load and by parallel operation of their own steam turbines and generators to relieve the power company of this burden or such part as might be required.

Handling the Load an Important Feature

The load dispatching in a large flour-mill plant is a matter of considerable importance, with water power, steam, and electricity available to carry the total load under the changing conditions of demands for flour and the water available in the river. Parallel operation of motors, water wheels, and steam engines have been made possible by these supplementary installations, and at times all three kinds of power have been used to drive one milling unit. This parallel operation is particularly desirable in such milling plants as purchase large blocks of power on a high fixed demand to enable them to use the power that is paid for.

This duplication of power units can be readily appreciated from the figures from one Minneapolis plant which required 14,000 hp. for full operation. The installed water-wheel equipment totaled 9000 hp., the steam engines 9000 hp., and the motors 12,000 hp., a total of 30,000 hp. available in prime movers or more than double that ever required in operation at any one time. The cost of power is small when compared with the cost of idleness, and in the early days the investment was not the governing consideration. The emphasis was placed on reliability and reasonable operating cost. Today, with changed economic conditions and a much smaller margin of profit on flour sales, it is a matter for careful investigation. In the future as the present equipment becomes obsolete or inadequate, each problem considering new equipment will be answered only after careful study of all the factors, the water power available, the cost of purchased electric power, maintenance, and particularly the probable operating load of the milling unit as a part of the total load of the plant.

In comparing the power figures of one milling unit with another it is important to make the comparison on the same basis. At Minneapolis the grain handling is done by a separate department, and this power is not included in the figures for mill operation-whereas in a smaller plant it is usual to take the total meter read ings of power for all purposes and charge the consumption against the output, in barrels of flour of 196 lb.

The process of milling is simple. It begins with the cleaning and separation of the wheat, removing the seeds and foreign matter. Next it is ground, then sifted, reground, and the middlings purified by air process to remove the bran particles, and this repeated again and again until the flour and feeds are put in bins,

packed, and loaded into cars. The mill operates as a unit, as a continuous process. Separate drives may be provided for the cleaning machinery and for the packing, and individual motors are occasionally direct-connected to the roll lineshaft, but start and stop together.

The flour mills in Minneapolis today range from 500 bbl. to 15,000 bbl. in capacity per day, in one unit. Perhaps the most economical unit is about 4500 bbl., as this has the advantages of economy in labor and supervision yet is not burdened by the greater cost and increased chance of expensive shutdowns as are the larger units. Production was originally figured in barrels per horsepower-day, and in the older mills ranged from $2^1/_2$ to 3 bbl. per hp. per day. Thus a mill requiring 1000 hp. should produce from 2500 to 3000 bbl. per day.

The coming of electric power has influenced these figures. Interpreting them in kilowatt-hours gives a power consumption ranging from $7^1/_2$ to 6 kw-hr. per barrel. Taking an average cost for power at Minneapolis of one-half a cent per kilowatt gives a cost from $3^3/_4$ to 3 cents per barrel, which is about one-half the normal cost in other typical cities of the country except Buffalo.

The mill load may roughly be divided as 15 per cent for wheat cleaning, 70 per cent for grinding (on hard northern wheat), and 15 per cent for sifters, purifiers, elevators, and packing. The torque required to start the mill with rolls apart is from 200 to 300 per cent of full-load torque. The daily operating load factor will range from 0.85 to 0.95, with a yearly load factor based on 720 hours per month as high as 0.70. The power factor in the larger plants is 80 per cent or over.

Looking backward we can see considerable progress. Looking forward, what does the future hold? The mill owners in the past have shown themselves to be quick to take advantage of improved methods and equipment and to be resourceful in applying them. The growth of engineering knowledge and the added responsibilities given in special fields insure that power will continue to receive proper consideration. When electrical engineers have perfected transmission of power by wireless, the flour mills will be ready to apply it and to make the first industrial application.

* * * *

The author, in reply to questions propounded by Messrs. Wm. L. Abbott[2] and Erik Oberg,[3] said that the price of $^1/_2$ cent per kilowatt-hour mentioned was the average cost of his company's water power, and not of that obtained from local electric companies. Some mills in Minneapolis not on the river were buying power at the regular commercial rates which were well over a cent. His company's average cost of power in Kansas City was 1.1 cents per kw-hr., and in Chicago about the same. The profit on a barrel of flour year in and year out would not run much over five cents a barrel. The flour-mill industry was one of those on the big-production basis, and the profit on each barrel was very small. In many cases it was just in the cost of the power. In one plant the power cost was 11 cents a barrel, and the difference between this and 3 cents was 8 cents—which was the profit on a barrel of flour. Formerly Minneapolis had wheat on one hand, transportation on the other, and power in between. Today, however, the only reason why Minneapolis continued to be a milling center was the fact that the mills were established there with their equipment. Other cities were now competing with Minneapolis because they had freight rates that were more favorable. Minnesota, once a great wheat state, did not now produce as much as Pennsylvania. The Dakotas were falling off, and for that reason the wheat fields in Canada got the benefit, and they shipped to Buffalo. Its power organization was all that was keeping Minneapolis in the first position.

The only Canadian wheat milled in the United States was that ground for export, and it was only a small proportion of the whole. There was a high duty on Canadian wheat, but by grinding it in bond at Buffalo, it could be exported again.

One of the factors that had influenced and increased the use of electric power had been the increase in reliability. Along with safeguards developed in the matter of lighting, it had developed the proposition of continuous milling, going through to the finished process without any interruption. The mills ran 24 hours a day, but the crews at night were only for the mere operation, packing and loading being done during the daytime. In recent years there had been very few explosions in flour mills. Investigation clearly established the causes of explosions, and these were promptly removed.

[2] Chief Operating Engineer, Commonwealth Edison Co., Chicago, Ill. Past-President A.S.M.E.

[3] Editor, *Machinery*, New York, N. Y. Mem. A.S.M.E.

A Scientist Looks at Mass Production

IT MUST always be the aim of an industrial organization to devise and set going one of those systems of manufacture on a large scale with which we have become familiar in recent years. With the aid of suitably designed machinery and methods, great numbers or quantities of some article in general demand can be produced at a comparatively small running cost. Generally, however, the initial cost is heavy, for the designing of the machinery and the planning of the methods call for great experience and skill, and they demand much time spent in the acquirement of the necessary knowledge and its utilization in design. Once the process is under way it may be possible, and it seems to happen on a sufficiently attractive number of occasions, that a smooth and peaceful running of the machinery brings in the wished-for returns. But every such phase of production comes to a natural end. An improved process is devised, and the new displaces the old. Or it may be a factory is set up in another country where laborers can be hired more cheaply; they may be intrinsically inferior, but that will not matter if they can be drilled into the mechanical process; and, as long as the machine runs true the standard will not fall below a certain value. The event is in accord with expectation because men will always try to improve their productivity by the use of new knowledge or more favorable conditions, so that those who fail to recognize the principle will be left behind by those who do not. The stereotyping of some process can only be fruitful for its allotted time. Mass production is in its way splendid, ministering to the necessities and conveniences of many who must otherwise have gone without. But if it is brought to such a pitch that its processes call for little intelligence in their working, then cheap people of little intelligence will be found, in the end, to be in charge.

The relation of science to mass production is therefore both that of builder and that of destroyer. Mass productions are temporary lulls in the movement of imagination and knowledge. Much skill and thought and care may be required to arrange for one of those quiet and profitable times; the machine is set going and for a while goes by itself. But new applications of scientific knowledge, new ideas, new processes, new machines must always be in preparation. In the parks the gardeners are always nursing fresh plants to take the place of the old, and preparing them for their useful time of flowering. And so we see the meaning of the various research organizations which have been set up in the basic industries, such as the Fuel Research Board, the Cotton, the Woolen, and the Silk Research Associations, the research laboratories of the steel masters at Sheffield. Much of our hope for the future is built upon their work.—Prof. Sir Wm. Bragg in his presidential address before the British Association, Glasgow, September, 1928.

Military Aviation

A Survey of the Development of Engineering Materials for Aviation Uses, the Air-Cooled Engine, and Bombing Equipment

By BRIGADIER-GENERAL WM. E. GILLMORE,[1] U.S.A.

THIS year will mark the twenty-fifth anniversary of the first successful power-driven flight by man.

Since that first memorable flight by Orville Wright, the airplane has gone through three distinct stages of development.

The first stage was purely the development of a craft that could safely propel itself and crew through the air.

Public interest during this early period manifested itself in the airplane as a sporting vehicle, and it received little thought and less encouragement as an implement of warfare until the outbreak of the World War.

The importance of the airplane for observation and reconnaissance was always appreciated by military authorities. There are few, however, who realized that the forced, intensive development of the war period would produce an implement of warfare that has seen no parallel in history since the discovery of gunpowder.

The use of the air arm, by the time the armistice was signed, both as a defensive and offensive weapon, was fully realized by all authorities, but its full possibilities had not been developed. In other words, the war merely presented problems which have remained for peacetime activities to solve.

When one considers that during the entire four years of hostilities but twelve tons of bombs were dropped on London, the magnitude of post-war development will be better appreciated when it is realized that this amount of explosive would today be carried in a single flight, and released with an accuracy undreamed of in 1918.

The second or military phase of aircraft development has seen its greatest progress in the past ten years, based on the problems presented and lessons learned during the war.

The tactics of aerial warfare require a variety of duties of such specialized natures that the airplane must be designed with an intimate knowledge of the particular purpose for which it will be used.

The tactical airplanes are now divided into four main groups: pursuit, bombardment, observation, and attack. In addition, there are others of a non-tactical nature suitable for training, transportation of personnel and supplies, and as ambulances for transporting the wounded.

Not only has it been necessary for the military establishments, who are so vitally interested in the use of the airplane, to develop the equipment used in carrying out military missions, but also the fundamental principles of airplane and engine design have been so thoroughly studied and recorded that they are the basis on which our rapidly growing commercial aviation is founded.

In aeronautical engineering there are not the past, the precedent, the traditions, and the engineering data that are the heritage of the mechanical and civil engineer of today, so that we must build up our data as we go.

The Army, in building up a foundation of engineering information for the designers, has destroyed in static test one each of every new design submitted, in order to prove by test that the engineering assumptions of the designers were fairly accurate.

The justification for going to the expense of destroying a complete airplane to prove an engineering theory lies in the fact that it has only been in the last few years that acceptable airplane structures have been completed on the first design.

All of these studies, although made on military structures, are of a fundamental nature, and the reports of these investigations have been published in books and pamphlets and distributed gratuitously to American aircraft designers.

The third or commercial stage of airplane development which is now so completely gripping the public interest, is profiting by the intensive development that has taken place in military aviation for the past ten years.

This third stage, however, is growing so rapidly and satisfactorily that it will only be a matter of time until commercial aviation, by its training of fliers, establishing of airways, and supporting of a substantial aircraft industry, will repay its debt to military aviation.

Studies of New Materials

In conjunction with the studies on the airplane structure and its stresses, there are the studies on new materials.

Up to and including the war period the universal material for the construction of the airplane proper was wood. Practically the only metals used were in the wheels and landing gear, and a few fittings in the fuselage and wings. In the modern plane the fuselage is constructed of seamless steel tubing welded at the joints and braced at frequent intervals with steel wires of high strength. The result is a fuselage or body that practically eliminates deterioration.

The most recent development in the construction of the fuselage is the substitution of an alloy-steel tubing for the tubing of common steel ordinarily used. As it is not safe to reduce the size of the tubing used in fuselage construction, the substitution of the alloy steel has not reduced the weight, but it has increased the strength more than fifty per cent.

The alloy-steel tubing now used in the fuselage of the modern airplane represents one of the most recent developments of the steel maker's art. It is a steel to which have been added the elements chromium and molybdenum. By the proper treatment during manufacture and fabrication, this chromium-molybdenum tubing has a strength of 90,000 lb. per sq. in. compared with 50,000 lb. per sq. in. for the common steel tubing ordinarily used.

In wings, metal has supplanted wood only in the larger airplanes—transports, bombing planes, and the like. The metal used for wing spars is an alloy containing about 93 per cent of aluminum, 4 per cent of copper, and less than one per cent each of iron, silicon, manganese, and magnesium. This alloy, the result of brilliant German metallurgical research, is known by the trade name "duralumin." Its weight is only about one-third that of steel, and after the proper treatment it has a strength of about 60,000 lb. per sq. in. or the equivalent of that of ordinary steel.

Although duralumin is seven times as heavy as the average wood, it is so much stronger that it can be used for wing construction without sacrificing any weight except in the case of small high-speed military airplanes. On this class of aircraft wood is used almost exclusively for wings.

There have been no new developments in metal for wing

[1] Chief, Matériel Section, Wright Field, Dayton, Ohio.

Presented at the National Meeting of the A.S.M.E. Aeronautic Division, Detroit, Mich., June 28 and 29, 1928.

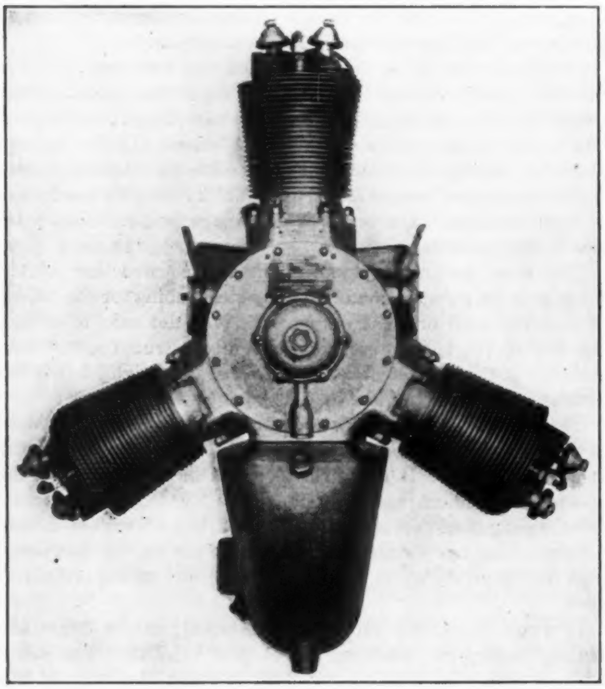
structures since duralumin was invented in 1909. No other light-weight alloy has been developed that surpasses it in its adaptability to wing structures. All development work in metallic wing sections has been in design, not in material.

Development in Engine Materials

There has been a remarkable development in aircraft engines in the past five years. This development has been along two lines: a reduction in weight per horsepower, and an increase in life and performance. Five years ago the average engine for military aircraft, without fuel, oil, and water, weighed about two pounds per horsepower. Today the average engine weighs approximately $1^1/_4$ pounds per horsepower. The reduction in weight alone amounts to more than 35 per cent. In addition the life and performance have been greatly increased.

The increased efficiency of the aircraft engine has been due to development in engine design, and to research and resulting improvement in metals. Light-weight alloys of aluminum are used wherever possible in aircraft engines; among the important parts made of these alloys are pistons, crankcases, exhaust manifolds, housings, and numerous small castings. In the air-cooled engine the cylinder head is also an aluminum-alloy casting.

The alloy duralumin already mentioned in connection with wing structures is also used for engine parts. In addition to duralumin there are two important light-weight alloys of aluminum, developments of recent years, which are used extensively

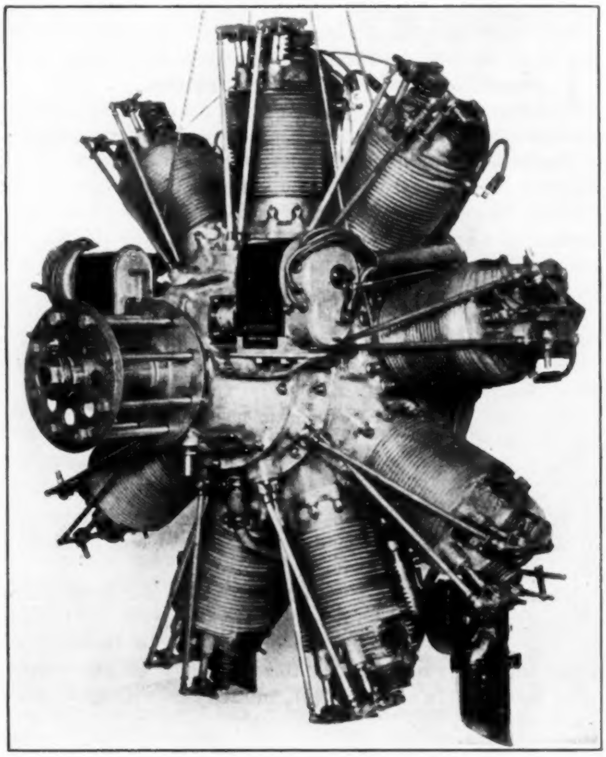


Three-Cylinder Lawrance Engine

in aircraft-engine construction. The first alloy, known familiarly as the "piston alloy," contains 88 per cent aluminum, 10 per cent copper, about $1^1/_4$ per cent iron, and $^1/_4$ per cent magnesium. A small amount of silicon is also present.

The second alloy is known as the "Y" alloy and is composed of 92 per cent aluminum, 4 per cent copper, 2 per cent nickel, $1^1/_2$ per cent magnesium, and small amounts of silicon and iron. These two alloys may be much improved in properties by heat treatment. By a process of treatment that in many ways resembles the "tempering" of steel the "piston" and "Y" alloy are made much harder and stronger. A valuable characteristic of these two alloys is that they retain this strength and hardness at comparatively elevated temperatures much better than any other known alloy of equal weight.

As a result of these valuable characteristics these two alloys are the best for pistons and air-cooled cylinder heads, which



Nine-Cylinder J-1 Lawrance Engine

in normal operation in aircraft engines attain a temperature of 450 to 550 deg. fahr. Next to duralumin the perfection of the "piston" and "Y" alloy is one of the most important recent developments in metals for aircraft. In fact, without these two alloys the air-cooled radial engine would not have reached its present state of perfection.

Several light-weight alloys of a new series are now under development for aircraft engines. These are the magnesium alloys. The most common one contains 95 per cent magnesium, 4 per cent aluminum, and about $^1/_2$ per cent manganese. A small amount of iron and silicon is also present. Magnesium alloys weigh approximately two-thirds what the common aluminum alloys do, and in the form of castings their strength is about the same.

In the present state of the development of magnesium alloys it is not possible to increase their strength by heat treatment, hence their application has been limited. Experimentally they have been made into pistons and cylinder heads, but it is somewhat doubtful if they will replace the standard aluminum alloys now used, at least not in the near future.

In the aircraft engine the alloys of magnesium have been used successfully, but still experimentally, for crankcases, exhaust stacks, and supercharger castings. The saving in weight with these alloys is considerable; a magnesium-alloy crankcase reduces the weight of a water-cooled engine $3^1/_2$ per cent, a substantial saving.

In recent designs the metal propeller has almost entirely

supplanted the wood propeller. The alloy used for propellers is a form of duralumin and contains 94 per cent of aluminum, 4 per cent copper, 1 per cent silicon, and $^1/_2$ per cent each of iron and manganese. This alloy has been the standard material for propellers for several years. Recent improvements in the metal propeller have been of design rather than material.

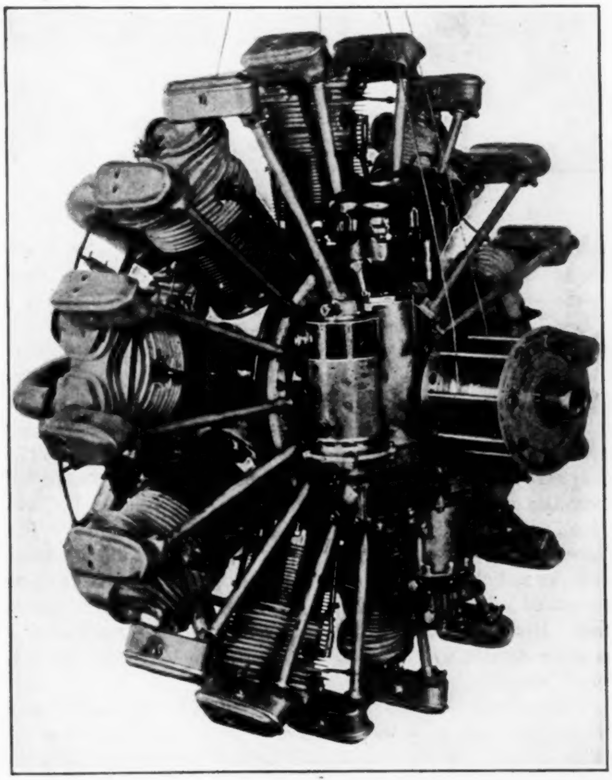
The magnesium alloy mentioned in connection with the airplane engine is a prospective propeller material. Already experiments have been made with this alloy. The alloy is much lighter in weight than any of the alloys of aluminum, and has a higher weight-strength ratio. In other words, a propeller made from the magnesium alloy would be stronger than an aluminum-alloy propeller of equal weight. This would permit the use of larger and stronger propellers without increasing the weight.

Air-Cooled Engines

It has seemed so eminently fitting that an air-cooled engine be used for the propulsion of aircraft, that no one has been particularly surprised at its recent really amazing advance. Those who have been least surprised are those who have forgotten that the air-cooled engine is practically as old in air activities as the water-cooled, and that in the early days of flying it played an extremely important part. Most of us have forgotten the pioneer air-cooled engines, the Renaults of 1907, the Anzanis of 1908 (with which Blériot first crossed the Channel), the Adams-Farwell rotary, and the early Curtiss air-cooled engines. We have nearly forgotten the Clergets, the Gnomes, the Le Rhones, the later Renaults, the A B C's, the Br-2's, and the RAF engines of the war. The period of apparent inactivity in air-cooled-engine development immediately after the war, when the war supply of air-cooled engines had been discarded and the water-cooled engine dominated the field, has erected a barrier our memories cannot easily surmount. But when we recall all these events it seems surprising, not that the air-cooled engine has forged ahead, but that it has taken so long to do it.

The delayed advance of the air-cooled engine was not a result of any failure to recognize its inherent advantages nor of any lack of interest in the type, but was due primarily to the inherently more difficult problem of cooling it presented. Obviously it is a much simpler task to direct a dense and relatively tractable cooling medium, such as water, into the recesses of the cylinder head to cool it than to direct into the same cavities a sufficient weight of air to accomplish the same cooling. The early engines developed rather low power and correspondingly low cylinder temperatures, and therefore presented a cooling problem of no great difficulty to either type. As the engine performances improved, however, the heat to be dissipated increased and the relative simplicity of the water-cooling problem began to show its influence. The rotary air-cooled engines to meet this difficulty produced a violent cooling air blast by the whirling of the cylinders, but at a considerable sacrifice of useful power. Some of the others resorted to auxiliary blowers for cooling-air supply, but most of them frankly overheated. To be sure, air-cooled engines were built in enormous quantities during the war and served well in the emergency, but they must be admitted to have contributed little to the advance of air-cooled-engine design. They were frantic efforts, spurred on by the wartime demands, to adapt an inadequate cooling system to new requirements. Their performance characteristics were little short of pathetic in contrast with such wartime water-cooled engines as the Hispano-Suiza, the Rolls-Royce "Eagle" and "Falcon," the Liberty, and even the Curtiss OX. Accordingly they were promptly discarded at the end of hostilities, and the water-cooled engine, to all appearances, dominated the field without prospect of competition.

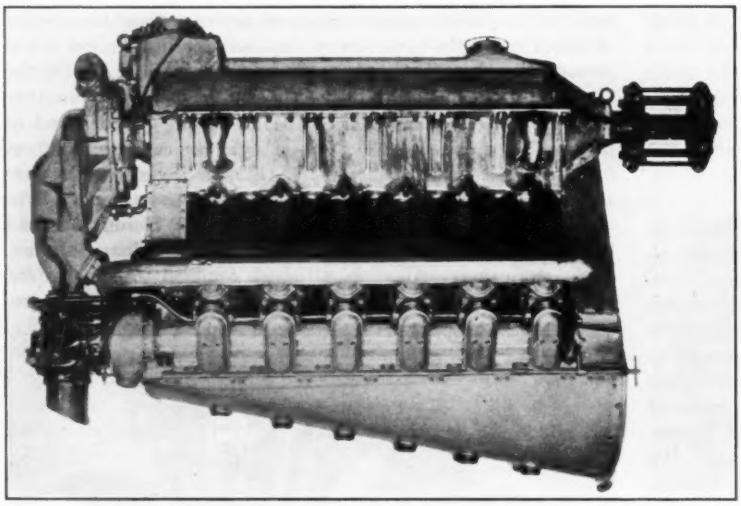
From that time until its recent reappearance, the air-cooled engine seemed to be dead. Popularly, its future was judged by its last public appearance, and it was given little consideration as a possible competitor of the water-cooled type. Actually, however, the engine for the first time was undergoing a thorough, systematic analysis. Its inadequacy, as demonstrated by the wartime examples, was fully realized. The situation clearly demanded drastic treatment, and the Royal Aircraft Establishment in England during the latter part of the War initiated a series of air-cooled-cylinder research investigations, the results of which indirectly have formed the basis for the success of the present-day air-cooled engine. Their investigations, under the direction of Dr. A. H. Gibson, consisted of an exhaustive analysis of the cooling requirements of the air-cooled cylinder and of painstaking studies of the type of cylinder construction best fitted to meet those requirements. Similar investigations were undertaken shortly afterward in this country by the Air Corps at McCook Field under the direction of S. D. Heron, who had been associated with Dr. Gibson in the preliminary studies. The American investigation, although founded to some extent on the early conclusions of Gibson regarding cooling requirements, was no less searching in other regards than that of the Royal Aircraft Establishment. Cylinder-head designs, valve arrangements, valve materials and cooling methods, cylinder-head attachments, spark-plug locations, cooling efficiency, valve mechanisms, and a hundred other items affecting the design of the air-cooled cylinder were minutely examined and tested, until a cylinder type was evolved which surpassed in performance characteristics and durability the best that the water-cooled engine could boast. The results were confirmed by the conclusions of the Royal Aircraft Establishment's studies, and the general cylinder type selected, the cast aluminum-alloy head screwed and shrunk on to a machined forged-steel barrel, from that time on became the accepted type for all high-performance



Curtiss R-1454 Engine

air-cooled engines. The establishment of a satisfactory air-cooled-cylinder design removed all doubt that the air-cooled engine could give the water-cooled power plant stiff competition. With equal performance and durability, greatly reduced weight, and elimination of the water-cooling-system troubles, the future of the air-cooled engine seemed secure.

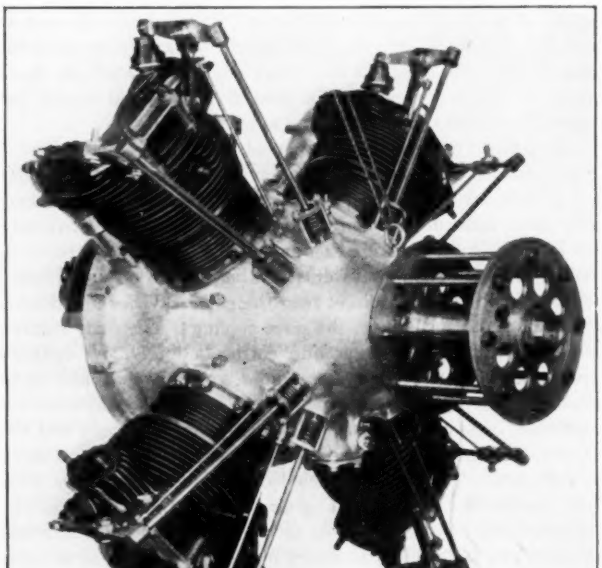
During this period of design study there had been little



AIR-COOLED INVERTED LIBERTY ENGINE

activity in the actual construction of complete air-cooled engines. The Air Corps, in 1920, undertook to stimulate interest in the air-cooled engine by opening a design competition for a nine-cylinder radial air-cooled engine suitable for pursuit duty, to develop approximately 350 hp. Several designs were submitted, but the engines constructed from those designs selected as the most promising met with indifferent success. (One of these engines, however, was rebuilt later with the screwed-head aluminum and steel cylinders with highly satisfactory results.) The only really outstanding accomplishments of the transition period were the engines designed and constructed by Charles L. Lawrance, one of the pioneers in the design of air-cooled engines. The three-cylinder 60-hp. engine of his "L" series, and his R-1 nine-cylinder radial, designed in 1920 for the Air Corps, were the first air-cooled engines to pass the Air Corps fifty-hour endurance test. His J-1 engine, slightly larger than the R-1 but identical in other details, was the first of the now famous Wright "Whirlwind" series.

The air-cooled engine as a real competitor of the water-cooled engine, however, may be said to date from the adoption of the screwed-head cylinder developed from the research studies of the Royal Aircraft Establishment and the U. S. Air Corps. For then only did the air-cooled cylinder performances compare favorably with those of water-cooled cylinders. The first of these engines was the Curtiss R-1454 built for the Air Corps, an engine of remarkable performance but so hampered by mechanical difficulties that its development was dropped in favor of more advanced designs. The second was the air-cooled Liberty engine built by the Air Corps on the standard Liberty crankcase, crankshaft, and connecting rods purely to demonstrate the practicability of an air-cooled V-type engine. The engine was inverted to improve visibility in flight and to facilitate disposal of exhaust. This engine not only demonstrated the practicability of the high-performance air-cooled V-type engine, but gave such satisfactory service that it has now passed on to service-test status in the Air Corps. The air-cooled avalanche has continued with the Wright "Whirlwind" J-5 (essentially the Lawrance J engine with the screwed-head cylinder), which has distinguished itself in several historic endurance flights and has been adopted as a standard training engine by the Navy and Army and almost universally by commercial air lines, a 230-hp. nine-cylinder radial engine of excellent performance characteristics and remarkable durability; the Pratt-Whitney "Wasp" of 400 hp., also adopted as standard by the Army and Navy and by several commercial air lines, an engine of brilliant performance and remarkably low weight; the Pratt-Whitney "Hornet" of 550 hp. similar to the "Wasp" in construction and in performance and in weight characteristics; the Wright "Cyclone" also a 550-hp. nine-cylinder radial of admirable design and performance characteristics; the Wright V-1456 a twelve-cylinder 500-hp. inverted air-cooled V-type engine in experimental status; the Allison X-4520, a 24-cylinder, 1200-hp. X-type engine now under construction; the Warner 7-cylinder 110-hp. air-cooled radial engine, a very promising commercial design; the Fairchild-Caminez cam engine, an interesting 4-cylinder radial engine of unconventional form; several experimental military service types not yet announced; and a vast crop of commercial designs, fifty-three by latest count and multiplying daily. The water-cooled engine is not yet obsolescent, but it has proportionally fewer friends particularly concerned about its future. In fact, unless some new



CAM RADIAL ENGINE, MODEL 4-447-A

development such as supercharging, high speed, two-cycle operation, or the like imposes cooling requirements beyond the capacity of the air-cooled cylinder, the continuance of the water-cooled engine seems highly improbable. The air-cooled engine appears to have taken permanent possession of the aircraft business.

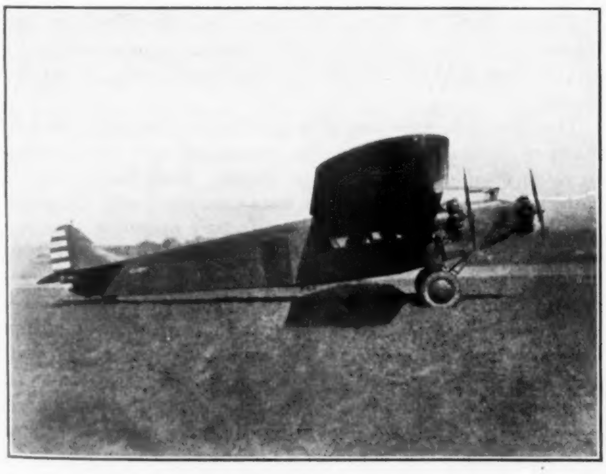
There can be little doubt that the first requisite of a successful aircraft engine in any type of service is dependability. In that

Curtiss P-1A Airplane

Douglas XO-2, P-374 Observation Airplane With Packard Engine

Curtiss O-1 Airplane, Remodeled

Keystone XB-1, XP-480 Airplane

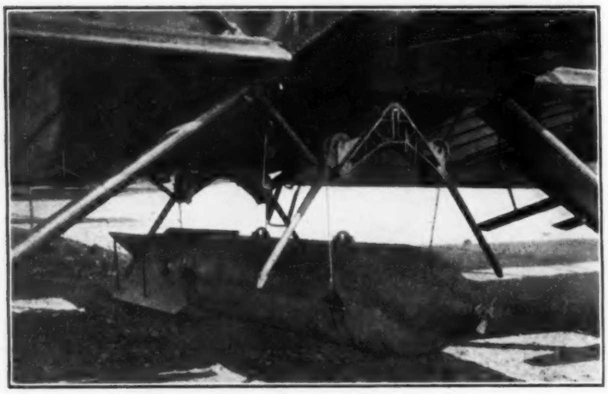


Atlantic C-2, P-463 Airplane, Side View

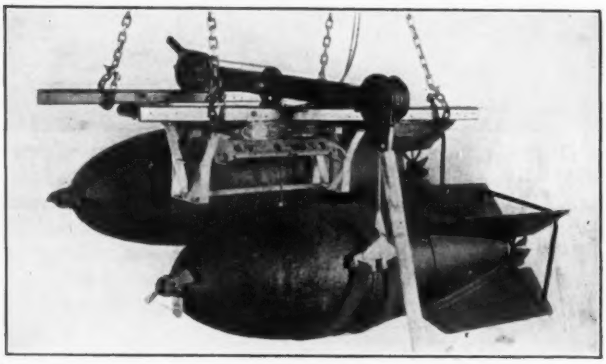
Atlantic C-2, P-463 Airplane, Front View

quality there can be no compromise. The aircraft, more than any other form of vehicle, is at the mercy of its power plant. The automobile or railroad train or even the seagoing vessel, if its propulsion ceases, can simply stop and await repairs or assistance. But the airplane, if its power plant fails, must make a landing immediately, wherever it may be. The airship, in even worse straits, cannot even descend with any degree of safety without engines but must remain aloft and drift until power is restored. Of course there can be no absolute dependability, but the engine that most nearly approaches it has gone far toward success. On this quality of power-plant dependability, more than any other, depends the popularization of air travel.

The order of importance of the other virtues that must be part of the successful aircraft engine varies with types of service and economic conditions. The matter of lightness is extremely important because it affects the performance of military aircraft and the pay load of civil aircraft. The power of the engine is tied up with weight in the same category. Durability affects both civil and military operations in varying degrees. Initial operating and maintenance costs and such engine characteristics as affect the comfort of the passengers are of greatest importance to commercial enterprises. All these qualities are primarily matters of design, built into the design on the drafting tables, but most of them proved, altered, and refined by exhaustive ground tests before the engines go into the air.



EXTERNAL BOMB RACK H-5, TYPE E-1 HOIST AND 2000-LB. BOMB



EXTERNAL BOMB, HOIST E-1, ONE 300-LB. BOMB LATCHED AND PARTLY RAISED TO EXTERNAL BOMB RACK R-3, RACK HORIZONTAL

Granting that dependability is the principal requirement, it is to be expected that the designer will direct his first efforts to that end. As a matter of fact he does not. Dependability, and durability too, are intangible qualities. They cannot be scaled off with dividers or computed with a slide rule. They can be well assured by safe, conservative design, but usually at the expense of lightness. So the actual process of the designer is to consider the horsepower requirements first, to design his engine as light as he dares, and then by actual tests to determine the dependability and durability of the result, making what changes the tests indicate are necessary to improve those qualities, but by this process keeping the unit weight as low as possible. The final proof of the engine, of course, is its flight service, but its flight service starts only after many hours of painstaking laboratory test have been completed. Its success or failure in service depends almost entirely upon development. Such qualities as production and maintenance cost, interchangeability of parts, and compactness are matters of design and are subject to little alteration thereafter, but the virtues or faults upon which the engine stands or falls, its performance characteristics, and its reliability and durability are products of the test laboratory.

ENGINE TESTS

The laboratory tests of aircraft engines are of two general types, performance tests and endurance tests. Ordinarily the performance tests are relatively brief. With the information now available and design characteristics there is little reason for an engine to fall far short of its designed performance. Rarely do the performance tests indicate the necessity for changes beyond the adjustment of valve or ignition timing or minor modifications of piston rings, intake passages, or carburetors. The performance tests have become hardly more than adjustment tests preliminary to the endurance tests to follow.

The extent of endurance testing considered necessary on a new engine increases from day to day. Five years ago an endurance test of fifty hours consisting of ten five-hour periods, each of one-half hour at full throttle and four and one-half hours at ninety per cent power, was regarded as a rather severe test, and any engine which could satisfactorily complete such a test without failure of any major part was considered a very good engine. But an engine designed today which fails a similar test of twice that duration with no forced stops and few, if any, adjustments other than routine service care, is regarded with little favor. The requirements as to reliability and durability, as reflected by laboratory tests, are becoming increasingly exacting, and not a few engines of recent design have accomplished non-stop endurance tests which several years ago would have been looked upon as hardly short of miraculous.

The standard Air Corps endurance test, the fifty-hour test, consists of ten 5-hour periods, each of one-half hour at full throttle and four and one-half hours at ninety per cent power (97 per cent speed).

The first endurance test of a new engine invariably discloses faults of design or construction, sometimes sufficiently serious to cause complete failure of the engine. Such faults must be corrected and further endurance tests conducted until the engine can demonstrate by continued satisfactory operation that it is satisfactory for flight. The process may require as few as three or four fifty-hour tests to reach that status, or the testing may run into thousands of hours, depending upon the excellence of design and the degree of departure from accepted standards. Obviously the engine which represents the greatest advance over its predecessors involves the widest divergence from what previously were considered the limits of design. Such an engine may be expected to require vastly more test development than an engine which is simply an enlargement or a refinement of an earlier model. The first notable advance in American aircraft-engine design since the design of the Liberty engine, the Curtiss D-12, spent several years in experimental test development before it was considered suitable for general flight service. Recent developments are accomplished more rapidly,

because increasing interest in aviation has made it economically possible to conduct several endurance tests simultaneously and so hasten the development, but the hours of test required for the development to flight status of an experimental aircraft engine have not been reduced materially. Nor has the importance of laboratory development been noticeably diminished.

Bombing Equipment

The bombing equipment in use during the war in England, France, Italy, Russia, Germany, and Austria was not flexible enough to carry different sizes and numbers of bombs by one mechanism. American engineers therefore sought to remedy this condition by the development of equipment that would be more universal. This was accomplished in a most satisfactory manner by designing a releasing unit called a shackle, which was attached to each bomb by means of two lugs or eyes, the spacing of the lugs being the same on the American 100-, 300-, 600-, or 1100-lb. weight. This one shackle will carry any of them interchangeably. In addition to providing ideal stability with one standardized unit, the use of two lugs caused the bomb to be carried horizontally. This is the ideal position at the instant of release because the bomb is pointed in the direction which it, as well as the airplane, is traveling at that instant. As the bomb falls, its speed of descent, starting from zero, increases very rapidly, and when that speed downward equals its speed forward, as furnished by the airplane, the fins or stabilizers on the bomb cause it to become inclined at an angle of 45 deg. with respect to a horizontal plane. As the speed downward increases, the bomb automatically and smoothly changes its direction to correspond with its momentary direction of flight. By causing the bomb to start its flight properly, its speed through the air will be uniform and its flight will be accurate. The smaller bombs of several European nations throughout the war were carried vertically. At the instant of release, the position, being at right angles to their direction of travel, is violently altered by the air pressure which causes the bombs to wobble, tumble, and oscillate for a long time after release, with the resultant variation to a true flight and great inaccuracy. Since the war, bomb racks have been designed to carry bombs of various sizes, up to twenty on one rack, simply by providing hooks for supporting the shackles and fingers to trip the shackle latches. The long 2000-lb. bombs are carried by means of a shackle built into, and as a part of, the rack structure. This rack gives also a combination hoist support whose hoist units are detachable to save weight. During the war the racks weighed approximately one-sixth of the weight of the total load of bombs carried. The European racks that carry more than one bomb at a time now weigh about one-tenth of the bomb load. American racks, which are much more universal, being made of high-grade heat-treated steel and duralumin, weigh from one-thirteenth to one-fiftieth of the bomb load, depending upon the type of rack and the bombs carried. The release handles are, in the majority of cases, very simple, being universal since the bomb control systems have been simplified and universally applied.

Armament in general, and aircraft armament in particular, is a rapidly changing and intensely interesting science, the development of which is progressing rapidly.

The bombs at present available range in sizes from 25 to 4000 lb. These, in combination with the bomb sights, which are a post-war development, make the present bombing airplane the most destructive weapon ever built for warfare.

Other Aeronautical Developments

The attack airplane, as in the case of the bombs, is designed primarily for offense. The attack airplane carries a complement of light bombs and six to eight machine guns, and is used for the harassment of troops on march or other emplacements susceptible to air attack.

The observation airplane has a mission of tremendous importance, for, as its name implies, it gathers and transmits to the ground commanders information regarding the movements and activities of the enemy.

The special equipment developed for use in the observation plane, for recording observations and transmitting information, are intensely interesting and worthy of more space than can be devoted to them in a paper of this nature.

The aerial cameras, both single-lens, and multiple-lens, and the methods used in producing maps from aerial photographs are military developments that have a very important commercial application. Last year the Air Corps photographed 17,000 square miles of territory in the Mississippi flood basin for the Flood Commission.

Radio communication from the airplane is another development which will play an active and important part in making commercial aviation safe. The radio beacon, which was developed at Wright Field, is a radio signal which is sent out directionally rather than broadcast, which informs a pilot of his exact course, and also any deviations he may make from his true course. These signals will guide a pilot to his destination, at night, or through fog, when it is impossible to discern landmarks. The radio beacon has been turned over to the Department of Commerce to be used in commercial aviation.

There are two important developments yet to be perfected before fog flying may be indulged in with any degree of confidence. One is a field localizer, and the other is a sensitive altimeter.

The radio-beacon signal will bring the airplane directly over the airdrome, but if the flying field is completely enshrouded in fog, the pilot is still in doubt as to the boundary location of the field and his exact elevation above the ground.

These two problems are now receiving a great deal of consideration, but as yet their solution is not in sight.

The airplane is the most important study in our national life, for it is the most important element in our national defense. The country that dictates the terms of peace in the next war will be the country that has the foresight to seize command of the air. The country that possesses an air force that commands the respect of the world need never fear invasion, and has purchased, and relatively cheaply, the surest guarantee of peace.

The Aircraft Radio Beacon

When the Aeronautics Branch was formed in the Department of Commerce in 1926, it determined that radio aids would be necessary on the civil airways, and assigned their development to the Bureau of Standards. The Bureau undertook to perfect the radio beacon, particularly by developing a visual indicator so that a pilot would have on his instrument board a direct indication of his location.

The directive radio beacon is a special kind of radio station usually located at an airport, just off the landing field. Instead of having a single antenna like an ordinary radio station, it has two loop antennas at an angle with each other. Each emits a set of waves which is directive, i.e., it is stronger in one direction than in others. When an airplane flies along the line exactly equidistant from the two beams of radio waves, it receives signals of equal intensity from the two. If the airplane gets off this line, it receives a stronger signal from one than the other.

With the beacon stations in operation throughout the country, airplanes in flight will always have the beacon signals available to keep them constantly informed of their locations.—Dr. George K. Burgess, Director, National Bureau of Standards, of the Department of Commerce in "Research Narratives."

Engineers in the Purchasing Department

Ideal Purchasing—Psychological Factors Involved in Purchasing—Cooperation Between Requisitioning Engineer and Purchasing Agent—Advantage of Having Engineers in Purchasing Department—Determining a Fair Price—Improving Specifications, Etc.

By C. F. Hirshfeld,[1] Detroit, Mich.

We deal this evening with the function of purchasing or procurement as the opposite and complement of the function of selling. The fact that the latter function has been studied and taught to the minutest detail while its complementary function, purchasing, until recently has been almost completely neglected, forms a very curious and very interesting commentary on our industrial and social development.

I am going to confine my remarks to the sort of purchasing that one meets in industry. We may call it industrial purchasing or engineering purchasing as against personal purchasing or purchasing for the satisfaction of personal or individual wants.

Ideal Purchasing Defined

Let us first determine what really constitutes ideal purchasing. Is it simply the procurement at the lowest possible price of a material or thing known by a certain name? I believe not. To me ideal purchasing is a far more complicated thing. It is exceedingly difficult to formulate a simple definition. The best that I have yet been able to produce in the way of a definition is this:

Ideal purchasing is the procurement of a given material or thing under such conditions that

a It has the qualitites necessary for the use in view

b It is acquired under such conditions that the maximum of usefulness is obtainable from it during its useful life

c It is acquired under such conditions that it will be certainly available for use when wanted, referring both to delivery and performance, and

d It is acquired at a fair price.

You note the order in which I list these things. Were I a purchasing agent I might reverse that order, but to me the arrangement used is the more logical. I say this because I do not believe that you can determine a fair price until you have given consideration to all the items that I have listed ahead of price.

Psychological Factors Involved in Industrial Purchasing

We might advantageously pause here for a minute and consider certain psychological factors of our problem. The greater part of industrial purchasing is done to meet needs determined by engineers, and the average engineer in industry is in the position of a requisitioner; that is, of one who directs that certain things shall be purchased. Theoretically, at least, he knows what is available for the particular problem in hand, and which of all the available materials or equipments is technically best suited to his needs. Also, theoretically, he is able to evaluate accurately the differences between the respective worths of the various things available so that he can determine how much more one is worth than another in any given market or at any given price level.

Practically, none of these ideals is in general completely the fact. Very few if any engineers can do accurately all of these things which are theoretically possible. And, being human, the average engineer naturally leans over in the direction of safety, sufficiency, and efficiency when requisitioning, and when deciding between different tenders for things named the same. Where he has found a given product satisfactory he hesitates to risk the purchase of an unknown or less well-known substitute. He has learned by experience that the glowing accounts of competitive salesmen must be taken with many grains of salt, and that the fact that so-and-so has purchased and is using a given material or equipment means little or nothing unless he investigates personally. And, in most cases he does not have time or opportunity for such personal investigation.

After all is said, the fact remains that it is the engineer who is responsible for physical results. Plant shutdown, high maintenance cost, unsatisfactory product, and dangerous conditions are all physically determinable facts, and they are charged up against the engineer when they occur or exist. It is therefore very natural and quite understandable that he should lean toward the purchase of that with which he has had satisfactory experience, that which has the best reputation, that which is marketed by the more representative and more stable manufacturers—in short, that he should be extremely conservative with respect to product, and that he should place many considerations before purchase price.

The purchasing agent stands at the other pole. Theoretically he is able to determine at any time what is a fair price. Theoretically he is able to determine the financial standing of all bidders, the chances of their meeting promised deliveries, and the probability of their remaining solvent and ready to give service during the useful life of the material or equipment that he is purchasing. Theoretically, as in the case of the engineer, he is able to do perfectly a lot of very desirable and necessary things. But, like the engineer, he also generally falls short of these theoretical capabilities. And, being human also, and recognizing that the most obvious measure of his efficiency is the dollars paid for this or that, he naturally leans over in a direction exactly opposite to that toward which the engineer leans.

Thus you have the requisitioner tending through force of circumstances to requisition either that which is most costly or to requisition in such a way as to result in high costs, while the individual responsible for filling the requisition is by force of circumstances driven in exactly the opposite direction. I have said nothing about constitutional tendencies. I might have, because in general the type that becomes an engineer tends toward high-price purchasing, while the type that becomes a purchasing agent tends toward low-price purchasing.

How to Effect Cooperation Between Requisitioning Engineer and Purchasing Agent

Let us now return to my attempt at a definition of ideal purchasing. The problem that confronts us is: How can the engineer and purchasing agent with basically different character-

[1] Chief, Research Department, Detroit Edison Company. Mem. A.S.M.E.

Address at a meeting of the Detroit Section of the A.S.M.E., Detroit, Mich., November 16, 1927.

istics, urges, and responsibilities so cooperate that purchasing of the type indicated by this definition may result?

I use the word "cooperate" advisedly, because cooperation is absolutely necessary. There are certain fundamental relationships between the requisitioning engineer and the requisition-filling purchasing agent which should be clearly enunciated and then later scrupulously observed. Since it is the engineer who is held responsible for the physical results obtained from the materials and equipment which he requisitions, it is obvious that he is the one who should have the ultimate decision as to what is to be purchased. Since it is the purchasing agent who is held responsible for the price paid, he should be left entirely unhampered with respect to all those things affecting the trading possibilities.

If you will study some of the many organizations in which there is constant bickering and friction between engineering and purchasing, I believe you will find that in most cases the poor relations have their seat in failure to observe this differentiation.

I do not mean to imply that observation of the differentiation necessarily means frictionless and satisfactory operation, but I am very certain that operation of such character is practically impossible without it.

Starting with this relationship assumed, we have as our simplest form an organization consisting of three parts:

a The requisitioning function, which prepares specifications as to physical characteristics, quantity and time of delivery, and requisitions on the basis of such specifications

b The procurement function, which obtains tenders on the basis of these specifications and ultimately settles on a price with a given vendor, effects the purchase, and arranges for the delivery

c The inspection function, which checks material or equipment in process, upon delivery or later, to determine whether it meets the specification.

Such an arrangement would or should work admirably in a very small organization in which one requisitioning engineer and one purchasing agent can handle the entire business and happen to be so constituted that they can work in close personal contact. But it becomes more or less hopeless when the organization grows so big that many more people are involved. Letters and memoranda, typed forms, and other modern expedients take the place of word of mouth in personal contacts, and very shortly we find the diverging psychologies and tendencies coming more and more to the front. The purchasing agent feels very certain that many of the specifications on which he is required to purchase are unnecessarily narrow and restrictive, and he is probably correct. The engineer feels that the purchasing agent is trying to make him accept something that is not exactly what he requisitioned, and he also is probably correct. Now if our fundamental conception is right, such a situation is all wrong; we are in danger of having the responsibilities of the different functions confused, to the detriment of both and ultimately of the undertaking that they are both trying to serve.

How are we going to combat such a development? Experience has shown that it may be prevented by recognizing the weaknesses of both sides and providing means which will counteract those weaknesses. Fundamentally, the engineer and the purchasing agent are attempting to do the same thing: namely, to cooperate to effect an ideal purchase as already outlined. Basically they approach the problem in different ways, speak different languages, and act on different impulses and ideas. We must find some way of bridging this gap in large organizations as it is bridged by personal contact and mutual understanding in small ones.

Advantages Gained by Introducing Engineers Into the Purchasing Department

It has been proved that this can be done by introducing engineers into the purchasing department. This does not mean that the purchasing agent need be an engineer; in many cases it is probably best that he be not one. It means that he is to have a certain number of engineering assistants; how many is determined by the number of different kinds of things to be purchased and the general volume of business done.

The function of these men is to become purchasing-department experts in the lines on which they respectively specialize. They are in fact members of that department, and they thus have the same measure of success as has their department chief. But they bring engineering knowledge and appreciation to their jobs, and they speak fluently the engineering language.

Let us see how the thing works out under several different conditions. We shall assume first a very common case. An engineering department has discovered a given material which works satisfactorily for a given purpose. It is purchased under some kind of name from a given producer. The engineer continues to requisition that material by that name, and the purchasing department discovers that the exclusive producer thereof is making hay while the sun shines. Were the purchasing agent to go to the engineer with the suggestion that something else be purchased he would undoubtedly meet violent opposition in the form of innumerable technical objections which he would be incapable of answering.

Now assume that he has in his department an engineer specializing in the field that includes this particular material. The problem is turned over to this specialist. He first finds out in such detail as may be necessary just what it is that the company is now buying and for what purpose it is used. By this I mean that he determines not the name but the characteristics of the material, and the way in which the use takes advantage of some or all of those characteristics. He then learns what other makes of similar or equivalent material are available, and determines in any way possible whether in his judgment one or more of them could be used as an alternative for the material now requisitioned. If he finds the situation promising he determines the possible saving in dollars per year.

Armed with such information he goes to the requisitioning engineer. The situation is such that the latter is placed in the position of having to prove to a fellow-engineer why he can not safely use one of the alternative materials suggested. Under the circumstances it develops quite frequently that the requisitioning engineer discovers for the first time in a real analytical sense why the material he is using is successful, and then that there are others capable of equally successful use.

I could cite many examples from experience, but time does not permit. Suffice it to say that the savings in dollars with equal satisfaction frequently run as high as 25 per cent of the earlier costs, and sometimes as high as 50 per cent.

Again, consider the case in which a manufacturer of equipment of a certain type is recognized as the best in the country. Frequently this is sufficient to cause the requisitioning engineer to call for equipment made by this manufacturer. The situation may be disguised for a time by asking others to submit competitive bids, but if such proposals are never accepted the sham ultimately becomes too transparent to be of any value. What does our engineer in the purchasing department do when he finds himself confronted with a situation of this sort?

He first determines by personal investigation whether the favored manufacturer really is as good in comparison with

others as the reputation he has established would lead one to believe. If he finds that the facts are as represented, he has two courses open. One is to determine whether by chance the equipment made by one of the competitors is good enough for the conditions of use. The other is to assist one or more of the "second-string" manufacturers to a really competitive position. And, in this connection, it is remarkable that in many cases this is accomplished quite easily. In either case the engineer of the purchasing department becomes armed with weapons quite capable of changing the requisitioning engineer's viewpoint in the matter.

Please note that I have not specified in this example what it is that has given the one manufacturer a practical monopoly. It may be the character of his product; it may be the character of service rendered; it may be a strong financial condition and conservative policy which promises long life and solvency during the useful life of the equipment; it may be the possession of leading designing and executive engineers whose performances in the past justify one in expecting equally satisfactory results in the future; or it may be any combination of all of these—and it frequently is.

As another example, assume that a given company requires a small piece of equipment in fairly large quantities, and that there is nothing on the market which meets the requirements. This has frequently happened in the light and power industry where new problems are being encountered continuously. Let us assume that one of the engineers of the company recognizes the need, is sufficiently resourceful to design something that will satisfy that need, and ultimately has some samples built in the company shops. If these samples prove successful in use it is quite probable that the company shops may be called upon to make thousands or tens of thousands in succeeding years.

If such things are obtained from the company shops by requisitions passing through the purchasing department, as they should be, a wide-awake engineer in that department will certainly investigate before long. Here apparently is a contrivance of some sort which is not an article of commerce in spite of the fact that huge quantities appear to be used. Why? Is this company the only one having use for such a device? If so, is it designed so as to involve the minimum expenditure for manufacture? And so on. It would surprise you greatly if I could tell the details of some of the cases that I know of. Suffice it to say that in one case running into thousands of articles a year the cost was cut to less than 50 per cent by a simple redesign which took advantage of commercially available parts and other things quite obvious to a man thinking in terms of dollars. And let me say that in this case the engineers responsible for the use of these devices are quite satisfied that they are just as satisfactory as those produced according to the original design.

As a further example, assume that an engineer of the purchasing department discovers that several requisitioning engineers of his company are calling for different makes of similar products or different products for similar purposes. This is not at all an unusual condition. A small amount of inquiry among the requisitioners combined with a little personal study of the different products and their uses in his company will frequently suffice to bring about such an agreement that the price advantages of larger orders and truly competitive conditions can be obtained. In such a case reduction of inventory and simplification of the work of the stores department also represent large potential savings.

Time does not permit me to continue to enumerate cases of different sorts. I think I have given enough to stimulate the imagination of any one who is particularly interested in such problems. I want now to turn to other aspects of the purchasing problem.

Determining What Is a Fair Price

If we regard purchasing over a long period of time it becomes quite obvious that vendors must, on the average, receive not only enough for their products to enable them to stay in business, but also to make them want to stay in business. This could of course result from selling to the favored, the wise, or the shrewd at low prices, and making up for it by overcharging others; or it could be achieved by selling to all at prices yielding reasonable profits over a period of years and with all things considered. While it is quite right for a large purchaser to take advantage of the size of his purchases in many different ways, I firmly believe that such large purchasers should recognize the fact that in the long run it is desirable for them to pay reasonable prices yielding reasonable profits—let us say a fair price.

Now, how do we determine what is a fair price? The old-fashioned purchasing agent had certain rule-of-thumb figures: so much per pound for cast iron, so much for brass, so much for steel, so much per thousand for brick, so much per pound for copper, etc. These formed his measuring sticks and he combined them with a huge ability to size up the other fellow and an equal ability to drive a close bargain. A fair price to him was frequently equal to, or lower than, the lowest price he could succeed in obtaining. And frequently all that he obtained in the way of reduction of price during a trading session merely brought the price to the value that would have been quoted originally had not the astute vendor anticipated just such a trading session.

Certainly we ought to be able to find some better method of attacking so important a problem. And certainly we can. An engineer who makes it his business to study a limited line of products can acquire a comparatively accurate conception of the various items entering into cost of production and into selling cost. These can be broken down into certain easily priced items such as material, labor, overhead on tools, and things of that sort, and into other items not so easily priced, such as the various loadings which have to be placed upon bare production cost to obtain a fair selling price. With experience, however, many of these loading figures become expressible as percentages or in other more or less indirect ways which can be made usable in building up a price from known basic material and labor costs. And thus the purchasing-department engineer gradually develops the statistics and the knowledge required to enable him to construct on the basis of existing material, labor, and money markets and the general state of business a reasonably accurate fair price for each one of the products falling within his field of specialization.

When you realize that with respect to many products their own makers cannot accurately determine total cost, you will realize that the degree of success achieved by one working from outside, as in a large purchasing department, must vary from product to product as well as from time to time. We must not expect too much. But it is surprising to discover how much is really obtainable by such methods, particularly as experience and comparisons are accumulated.

Consider now the position of the purchasing agent who has such means at his disposal when he enters a discussion with a bidder or a group of bidders whose prices he believes to be too high. General statements by the vendor's agents mean nothing to him, nor is last year's price or that of several years ago particularly significant as a total, nor are any of the standardized sales appeals of much use. The prospective vendor is automatically placed in a position in which he has to point out the error in the purchaser's constructed price, or quite completely justify his own quotation. Of course the thing is not perfect by any means, but in so far as it goes it tends to bring some sort of rational discussion into what was formerly quite frequently

more a case of bluff on both sides, and it does tend to protect both vendor as well as vendee against prices unfair in either direction.

Let me here call attention to the fact that it is easy to assume more than I have intended in the several preceding paragraphs. I do not mean to imply that a fair price is always one which yields the vendor a legitimate, average profit on that transaction. All sorts of complications enter, such as increased profit on all orders by virtue of increased output, or such as the desirability of disposing of surplus inventory, or such as the desire to show on the books a certain volume of business. All things of this sort should be properly taken into account when attempting to construct a fair price; that is, such a price is determined partly on a technical basis and partly on a purely business or commercial basis.

A very interesting and valuable by-product results from the use of engineering specialists in the purchasing department. These men naturally keep in close touch with the trade conditions in their specialties, and also with price movements of raw materials and of labor entering into those products. They also learn about what supplies and equipment of different sorts are purchased each year, what the annual quantities are, how the purchases are spread through the year, and so on. With such information available it is comparatively easy for them to make suggestions of great value to the requisitioning engineers. They can save money for the company by bringing about an earlier purchase or a later purchase, by consolidating the year's requirements into one order instead of several placed at different times, and so on.

Improvement of Specifications

There is one further point to which I should like to direct your attention. The first step in a purchasing transaction is the determination of what is to be purchased and the preparation of an accurate description thereof. We call this description quite properly a specification. But it is a sad fact that many specifications as prepared by engineers are not adequate descriptions. This situation is being improved through the efforts of many organizations, but there is still room for much further improvement.

Now assume that an incomplete or an ambiguous specification prepared by a requisitioning engineer finds its way in the course of routine to the desk of an engineer in the purchasing department. It is his business to read this specification very closely as one step in his part of the job. He has his mind on all the possible products which may be supplied under a given requisition, whereas the requisitioning engineer generally writes the specification toward a mental picture of just what he wants. The purchasing-department engineer has in mind a possible string of financial adjustments and settlements which will probably be more difficult and less profitable as the specification lacks completeness or accuracy. He is thus in an ideal position to determine in what directions and to what extent the specification is lacking. And, being an engineer, he can talk the matter over in an understanding way with a brother-engineer and get as a result a satisfactory purchasing document.

I can tell you from experience that the thing works in this way. The installation of engineers in the purchasing department does not only result in a marked improvement in specifications and a smoother operation of the purchasing function as a result, but it also generally discloses innumerable purchases which in effect have been without any specification. You would be inclined to think that impossible, but just look closely into the workings of any large industrial organization and learn for yourself.

In closing, please let me assure you that I am not assuming to give you the results of any remarkable discoveries, nor do I believe that I am blazing any new and unknown trails. I have merely tried to paint a verbal picture showing why engineers should be included in the purchasing departments of large industrial undertakings, and what an important service they can render and are rendering there if the organization is properly set up. Note that engineers have been and are so employed in some purchasing departments; they should occupy positions in more of them.

The Textile Engineer—His Training and Opportunities

By HERBERT J. BALL,[1] LOWELL, MASS.

WHO IS a textile engineer, and wherein does his equipment differ from that of any one else, are questions which may well be asked. A textile engineer is one whose basic training has been in engineering and the fundamental sciences upon which it rests, but to which has been added a very thorough knowledge and understanding of the raw materials, processes, and machines peculiar to textile manufacturing. It is this equipment which causes him to approach textile problems from the scientific standpoint, and to decide them, not on a rule-of-thumb or empirical basis, but upon the basis of clearly established laws, facts, and principles. And should the required data be missing or incomplete, his analytically trained mind and his knowledge of methods of research will disclose where or how the gap may be filled. This contribution which he brings to the industry furnishes the scientific foundation upon which its future advancement and progress rest, and is a very similar contribution to that which other engineers with different designations are making to their respective fields of industry, art, and science.

The young man who is desirous of obtaining the training requisite for a textile engineer can hardly hope to acquire it solely by mill experience. This process is a long and tedious one at best, and even then there is no assurance of its continuity nor that at the completion of the apprentice period the desired results will have been attained. Since industry today has come to recognize the college as the training school for its future executives, it would seem, therefore, that he should turn to the textile school or college where prescribed courses of study may be found which embody these requisites. By pursuing here a four-year course of study, following a high-school education, it is possible to secure in the shortest practical time a thorough grounding in the engineering sciences and the textile processes.

Fig. 1 has been prepared to make it easy to visualize the most important elements which should be comprised in the technical training of a textile engineer and also to set forth some of his business opportunities. It has been prepared from the curriculum of the textile engineering course as now given at the Lowell Textile Institute. It is interesting to know that this course was originally started in response to a very definite demand from the industry for such men. It has been changed and improved since its inception to keep pace with modern demands, and in its

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present form represents the result of over twenty years of experience.

The upper half of the diagram contains a list of most of the subjects, as now given, arranged in certain natural groups, the textile, the engineering, the business, and the general group. The space taken up by each is not to be considered in any way as indicative of either the importance of the subject or the time devoted to it. Each one plays the part for which it is intended in the man's training, and in doing so helps to develop his latent

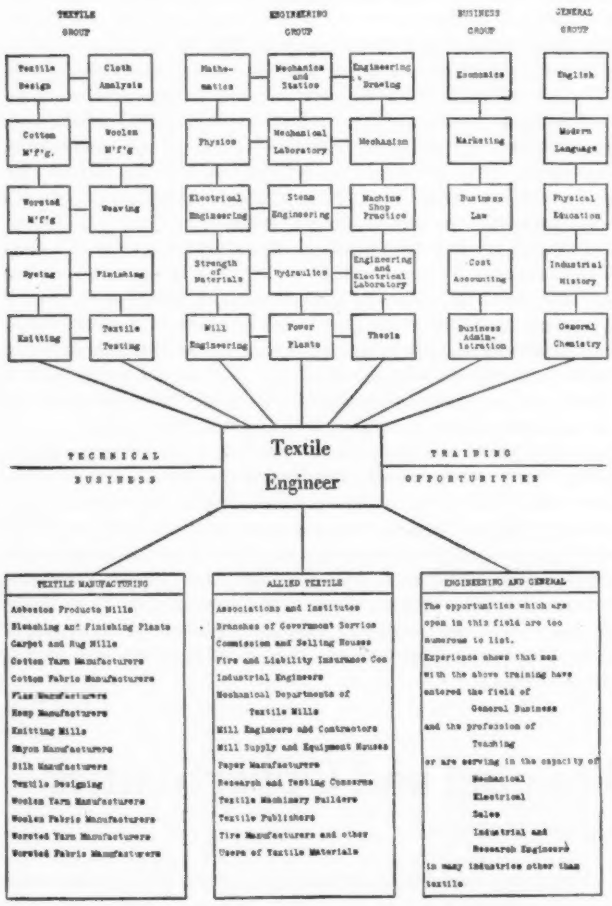


Fig. 1 Chart Showing the Technical Training and Business Opportunities of a Textile Engineer

abilities, to increase his store of knowledge, and finally to produce a broadly trained textile engineer.

The engineering group of studies, which forms the backbone of the course, is the one which provides the knowledge in the fundamental sciences upon which all manufacturing largely rests. They are of great importance further in inculcating systematic and orderly habits of thought, and in developing analytical and reasoning power. This group is powerfully supported in its objectives by the textile group, a list of studies comprising the major textile processes and operations and in which are given thorough and technical instruction in the theory and practice of yarn and fabric production. One finds in the modern business establishment of today a highly developed organization with its departmentalization, its fine division of duties and responsibilities, its intimate control of productive activity, and particularly the keen competition among the personnel for positions of honor, power, and financial reward. It would seem that the textile engineer who hopes to make a place for himself should at least be aware of those principles by which business is managed and conducted; hence the inclusion of the business group. By the same token and still further to round out and broaden his viewpoint, there are included other subjects in the general group which are deemed essential to the training of the Bachelor of Textile Engineering.

The question as to whether a course of this character is productive of a practical and useful type of engineer who can stand up under the stress of business is answered best by reference to the lower half of the same chart. This is a compilation, which does not pretend to be complete, of the business opportunities which are open to the textile engineer. It has been drawn from the actual list of firms which have absorbed the engineering graduates of the Lowell Textile Institute in the past years. A careful, thoughtful study of the list must certainly convince the reader of the remarkable extent of the fields which are open. As has been stated previously, this course grew out of an actual demand for men with a technical and textile training, and it is interesting to record that the demand has steadily and constantly increased and at the present writing seems to give clear indication of being in excess of the supply.

In the first column, under the title of "Textile Manufacturing," reference will be found to practically every important fiber which is used for the manufacture of yarns and fabrics. In other words, the entire textile manufacturing industry finds a use and a need for a textile engineer. The methods of manipulation of fibers are all so similar in their general characteristics that a thorough knowledge of the cotton, wool, and worsted processes seems to offer such adequate equipment that he can assimilate quickly those lesser differences which he finds in the processing of other fibers. If one will really inquire into the infinitely varied uses, common and unusual, to which textiles are now put, and will realize the enormous quantities which are being consumed daily throughout the world, if one will also remember that the textile industry is rated as the third or fourth largest in our own country, then a better conception will be obtained of the true scope of the opportunities which seem to be stated so briefly under the above heading.

The title "Allied Textile," used for the second column, is intended to designate those fields of business activity which do not involve the direct manufacture of textiles but to which a textile knowledge is essential. This huge textile industry must be supplied, for example, with properly designed machinery and equipment, with supplies of almost infinite variety, and with equally numerous services of an indispensable sort. Here also will be found only a mere mention of just a few of those other industries, in themselves large, which use finished textile products as raw materials, but upon the properties and qualities of which rest the success of their own manufacturing processes. The textile engineer finds many demands for his services from this field alone.

The third title, "Engineering and General," has been used to describe an equally broad classification of business opportunities. The training of the textile engineer as described above has proved to be so fundamental that graduates whose final inclinations have been toward engineering rather than textiles have found ample opportunities for their services in strictly engineering lines. This is such a wide field in itself that it is out of the question to attempt to list the possible occupations in this paper. Let it suffice to say that practical experience shows that textile engineers have entered the field of general business and the profession of teaching, and are serving in the capacity of mechanical, electrical, sales, industrial, and research engineers in many industries other than textile.

Surely textile engineering presents an opportunity which should challenge the full capabilities of any young man of latent ability and promise.

Preferred Numbers for American Practice[1]

A Proposed Semi-Geometric Series Which Applies to the Original Design of a Product the Laws Governing Standardization and Simplification

By MYRON E. STECZYNSKI,[2] CHICAGO, ILL.

FOR several years past, preferred numbers have attracted much attention in European engineering circles. Many Continental European countries have adopted to a greater or lesser extent tables of preferred numbers from which dimensions for manufactured articles are chosen. It is claimed that this practice is favorable to standardization and prevents the manufacture of a uselessly great variety of sizes of the same object, and also permits economical correlation of supplementary equipment. The European preferred-numbers series are supposed to include numbers that are actually preferred above all other numbers by European industry. It is further claimed that these preferred numbers are arranged in an entirely logical way so that minimum variety will serve maximum utility.

The great attention given to standardization in this country has caused many people to advocate the European preferred-numbers series as the key to complete standardization for American industry. The author feels that the Continental European series, being designed for metric units, would not be acceptable to American engineers who are accustomed to English units. It is shown in this paper that the European preferred numbers are not so logical as claimed and not so preferable as advocated, and it is indicated that what American industry needs is not so much a mathematical series of computed numbers as a logical arrangement of all existing numbers which, used intelligently, would tend to weed out certain uncommon numbers and to concentrate on certain preferred numbers. To this end a so-called semi-geometric series is presented as a proposed standard for American industry. This series lists all numbers into orders of preference called "first order of preference," "second order of preference," etc. It is shown that if manufacturers endeavored sincerely to choose dimensions from the first three or four orders of preference, great economy in manufacture would result.

Table 1 is a list of numbers from $^1/_{64}$ to 1984 proposed as a standard list of dimensions for American industry.

The first column, headed "1st Order," lists a geometric series beginning with $^1/_{64}$ and having a ratio of progression of 2, so that the terms are $^1/_{64}$, $^1/_{32}$, $^1/_{16}$, $^1/_8$, $^1/_4$, $^1/_2$, 1, 2, 4, etc. The second column, headed "2nd Order," lists arithmetical means between the terms of the first order. The third column, headed "3rd Order," lists arithmetical means between the terms of the first and second orders; and the successive orders, shown in successive columns, are formed by extension of the law already used in forming the first three columns. This series is presented as a scientific basis for size determination whereby great economy in manufacture, illustrated by the following example, could be obtained. Suppose that a series of circular objects from $^1/_{64}$ in. to 8 in. in diameter were to be manufactured. If the dimensions were chosen from the proposed standard and only the first three orders were used, actual count of the terms in the table would give 32 sizes of diameter, neglecting fractions having denominators greater than 64. These 32 diameters would require 32 sets of tools, gages, etc. If these same articles were made by a large number of manufacturers and each manufacturer were to use the proposed standard, only 32 sizes of tools would be required by the whole industry, whereas if each manufacturer were to determine sizes according to his own judgment, the number of sizes of tools required would be infinitely larger. It will be seen, then, that adoption of the proposed standard would lead to greater economy of production and at the same time would allow correlation of supplementary parts. The objection might arise that the proposed standard gives too few or too many diameters between the limits of $^1/_{64}$ in. and 8 in. This, however, could be corrected by adding another order of terms or by taking away one order of terms. The table could be expanded or contracted, following the very apparent law of its formation, to cover a greater or lesser range as desired.

This argument has been based on dimensions in inches for purposes of concrete illustration, but it will be readily seen that the proposed standard could be applied to volumes or weights or any other type of dimension. In fact, the proposed standard conforms absolutely to the following desiderata stated by Messrs. Hirshfeld and Berry who presented a paper[3] on "Size Standardization by Preferred Numbers" before the A.S.M.E. in December, 1922:

a The series must be as simple as possible.
b The series should be suitable for use in various arts and industries, the very same series being used to designate magnitudes in feet, inches, pounds, tons, gallons, kilowatts, square feet, etc.
c The series should cover a very wide range of relative magnitude.
d The series should be capable of easy reduction by the omission of intermediate terms, so that various numbers of steps can be secured within any desired range of magnitude. Such shorter series should conform to desiderata, *a*, *b*, and *c* in the same manner as the complete series.

Conformity with desiderata *a*, *c*, and *d*, is obvious; and conformity with *b* can easily be proved by selecting a series of numbers from the table and by multiplying these by any of the common conversion factors (such as 12 for conversion from feet to inches or 4 for conversion from gallons to quarts), whereupon the resultant numbers will also be found to be terms of the proposed standard.

Proposed Standard Psychologically Correct

The proposed standard is psychologically correct, being based upon the Fechner-Weber law which, when applied to size, states that one's ability to distinguish size follows a geometric progression; one instinctively says that a given object is so many times larger than another object rather than so many pounds heavier, preferring to distinguish size by geometric ratio rather than by arithmetical increment. Nor would the proposed standard conflict with industry's psychological and economic resistance to something new, because it is based upon a system of measurement already in use and conforms with the tendency of American industry toward "dichotomy," or the use of fractions formed by bisection. This at once distinguishes the proposed standard from European systems of preferred numbers that have been suggested as suitable for application to American industry. These latter would involve decimalization of all American quantities, and do not actually constitute exact series but are rounded-off approximations to the somewhat impossible decimals of the

[1] A paper on the application of preferred numbers in Germany, by Prof. Dr. von Dobbeler, will appear in the December issue.—Editor.

[2] Chief Engineer, Knight Soda Fountain Co. Assoc-Mem. A.S.M.E.

[3] Mechanical Engineering, December, 1922, p. 791.

TABLE 1 ORDER OF PREFERENCE (RELATIVE IMPORTANCE) OF SEMI-GEOMETRIC SERIES, MEDIUM RANGE

1st Order	2d Order	3d Order A	3d Order B	4th Order A	4th Order B	4th Order C	4th Order D	5th Order A	5th Order B	5th Order C	5th Order D	5th Order E	5th Order F	5th Order G	5th Order H
1/64	3/128 0.02344	5/256 0.01953	7/256 0.02734	9/512 0.01758	11/512 0.02148	13/512 0.02538	15/512 0.02930	17/1024 0.01660	19/1024 0.01855	21/1024 0.02051	23/1024 0.02246	25/1024 0.02441	27/1024 0.02637	29/1024 0.02832	31/1024 0.03027
1/32	3/64	5/128 0.03906	7/128 0.05469	9/256 0.03516	11/256 0.04297	13/256 0.05078	15/256 0.05859	17/512 0.03320	19/512 0.03711	21/512 0.04102	23/512 0.04492	25/512 0.04883	27/512 0.05273	29/512 0.05664	31/512 0.06055
1/16	3/32	5/64	7/64	9/128 0.07031	11/128 0.08594	13/128 0.10156	15/128 0.11719	17/256 0.06641	19/256 0.07422	21/256 0.8203	23/256 0.08984	25/256 0.09766	27/256 0.10547	29/256 0.11328	31/256 0.12109
1/8	3/16	5/32	7/32	9/64	11/64	13/64	15/64	17/128 0.13281	19/128 0.14844	21/128 0.16406	23/128 0.17969	25/128 0.19531	27/128 0.21094	29/128 0.22656	31/128 0.24219
1/4	3/8	5/16	7/16	9/32	11/32	13/32	15/32	17/64	19/64	21/64	23/64	25/64	27/64	29/64	31/64
1/2	3/4	5/8	7/8	9/16	11/16	13/16	15/16	17/32	19/32	21/32	23/32	25/32	27/32	29/32	31/32
1	1 1/2	1 1/4	1 3/4	1 1/8	1 3/8	1 5/8	1 7/8	1 1/16	1 3/16	1 5/16	1 7/16	1 9/16	1 11/16	1 13/16	1 15/16
2	3	2 1/2	3 1/2	2 1/4	2 3/4	3 1/4	3 3/4	2 1/8	2 3/8	2 5/8	2 7/8	3 1/8	3 3/8	3 5/8	3 7/8
4	6	5	7	4 1/2	5 1/2	6 1/2	7 1/2	4 1/4	4 3/4	5 1/4	5 3/4	6 1/4	6 3/4	7 1/4	7 3/4
8	12	10	14	9	11	13	15	8 1/2	9 1/2	10 1/2	11 1/2	12 1/2	13 1/2	14 1/2	15 1/2
16	24	20	28	18	22	26	30	17	19	21	23	25	27	29	31
32	48	40	56	36	44	52	60	34	38	42	46	50	54	58	62
64	96	80	112	72	88	104	120	68	76	84	92	100	108	116	124
128	192	160	224	144	176	208	240	136	152	168	184	200	216	232	248
256	384	320	448	288	352	416	480	272	304	336	368	400	432	464	496
512	768	640	896	576	704	832	960	544	608	672	736	800	864	928	992
1024	1536	1280	1792	1152	1408	1664	1920	1088	1216	1344	1472	1600	1728	1856	1984

Direction of Preference → ← Direction of Elimination

exact European series. On the other hand, all of the terms of the proposed standard are exact terms, and, as has already been indicated, the series is capable of infinite expansion.

The author was led to the proposed standard, which can be called a semi-geometric series of preferred numbers, by noting the tendency of human beings to prefer numbers that are formed

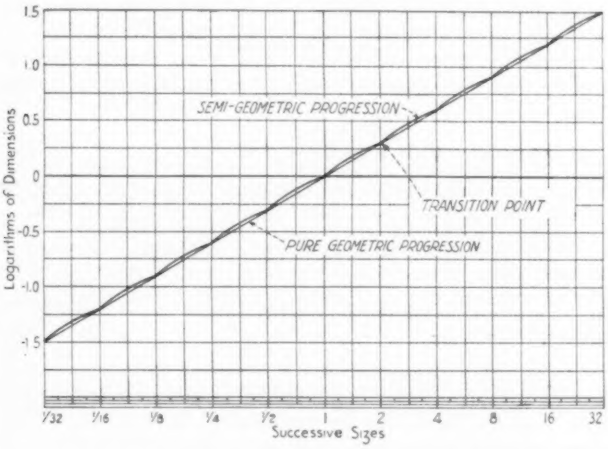


Fig. 1 Progression of Semi-Geometric Series

by halving or doubling (dichotomy), and also by experiment with various series on all kinds of dimensions. The following explanation deals with the order of preference of the terms in the proposed standard and refers to Table 1. The first order of preference is based on unity, and consists of those common multiples and divisions of unity which first come to one's mind when thinking of geometric progression, viz., 1/4, 1/2, 1, 2, 4, 8, etc. The second order of preference consists of values arithmetically intermediate between successive values of the first order of preference, and contains numbers which decidedly augment and extend the usefulness of the first order of preference. The third order of preference consists of two columns, the one on the left being preferable to the one on the right, because the values in the left-hand column can be used in a logical series with the values of the first and second orders without using the values in the right-hand column of the third order. The fourth order of preference has four columns within itself, those to the left being preferable to the columns on the right-hand side. The fifth order of preference has eight columns, the sixth order sixteen columns, etc. Each series in a vertical column increases by 100 per cent, in this way being in pure geometric progression. The basis for the determination of order of preference is simple and logical: from every-day experience the binary divisions are the most-preferred values and rank in the order of bisection or halving (e.g., 1/2 is preferable to 1/4), and for fractions of the same denominator those of smaller numerator are preferred (e.g., 1/4 is preferable to 3/4).

The relationship between the various series is in *arithmetical progression*, with *uniform numerical* increments between the respective series instead of *uniform percentage* increments. The *order of preference* in this table is from the left to the right, and the *order of elimination* is from the right to the left. In choosing a number, size, or dimension, an effort should be made to select a value from the first, second, and third orders of preference.

Values of the first five orders of preference are rearranged in Table 2 in the *order of magnitude*, with the various orders of preference offset horizontally in their respective columns.

In this way the first column gives only values of the first order, the second column of the first two orders, the third column of the first three orders, the fourth column of the first four orders, and the fifth column gives values of the first five orders of preference. These tables are similar in arrangement to those in which the European series are usually presented.

None of the values in the tables are approximations. They are all exact and fit into the series perfectly. Each series can be extended in magnitude indefinitely by means of the law already described or by shifting the decimal point for values beyond such limits as 1/64 and 100, for example. The number of series or orders of preference can be developed without limit, permitting all numbers to be classified. When arranged in the order of magnitude the short ranges of numbers are in arithmetical progression; however, the general gradation is geometric, as may readily be seen from Fig. 1, which shows this semi-geometric series plotted with the logarithms of size or dimensions as vertical ordinates. The wavy line is the graph of the semi-geometric series, and the straight line the graph of the corresponding pure geometric series. It will be noted that the two graphs touch at regular intervals which are values of the first order of preference.

French and German Preferred-Number Series Not Suitable for American Industry

Study of preferred numbers as used in metric countries such as France and Germany shows that their series are not at all suitable for American industry. Table 3 shows the simplified values of the German series of preferred numbers. The application of this German series is feasible only where common usage resorts to a decimal division of values as in the metric system. American machine-shop practice, however, centers about dichotomous or binary fractions such as sixteenths, eighths,

TABLE 2 MEDIUM RANGE OF PREFERRED NUMBERS, SEMI-GEOMETRIC SERIES

Values 1/8 to 1 — Order					Values 1 to 8 — Order					Values 8 to 64 — Order					Values 64 to 512 — Order				
1st	2d	3d	4th	5th	1st	2d	3d	4th	5th	1st	2d	3d	4th	5th	1st	2d	3d	4th	5th
1/8	1/8	1/8	1/8	1/8	1	1	1	1	1	8	8	8	8	8	64	64	64	64	64
...	...	...	...	...	...	...	...	...	1 1/16	...	...	...	...	8 1/2	...	...	...	...	68
...	...	...	9/64	9/64	...	...	...	1 1/8	1 1/8	...	...	...	9	9	...	...	...	72	72
...	...	...	...	...	...	...	...	...	1 3/16	...	...	...	...	9 1/2	...	...	...	...	76
...	...	5/32	5/32	5/32	...	...	1 1/4	1 1/4	1 1/4	...	...	10	10	10	...	...	80	80	80
...	...	...	...	...	...	...	...	...	1 5/16	...	...	...	...	10 1/2	...	...	...	...	84
...	...	...	11/64	11/64	...	...	...	1 3/8	1 3/8	...	...	...	11	11	...	...	...	88	88
...	...	...	...	...	...	...	...	...	1 7/16	...	...	...	...	11 1/2	...	...	...	...	92
...	3/16	3/16	3/16	3/16	...	1 1/2	1 1/2	1 1/2	1 1/2	...	12	12	12	12	...	96	96	96	96
...	...	...	...	...	...	...	...	...	1 9/16	...	...	...	...	12 1/2	...	...	...	...	100
...	...	...	13/64	13/64	...	...	...	1 5/8	1 5/8	...	...	...	13	13	...	...	...	104	104
...	...	...	...	...	...	...	...	...	1 11/16	...	...	...	...	13 1/2	...	...	...	...	108
...	...	7/32	7/32	7/32	...	...	1 3/4	1 3/4	1 3/4	...	...	14	14	14	...	...	112	112	112
...	...	...	...	...	...	...	...	...	1 13/16	...	...	...	...	14 1/2	...	...	...	...	116
...	...	...	15/64	15/64	...	...	...	1 7/8	1 7/8	...	...	...	15	15	...	...	...	120	120
...	...	...	...	...	...	...	...	...	1 15/16	...	...	...	...	15 1/2	...	...	...	...	124
1/4	1/4	1/4	1/4	1/4	2	2	2	2	2	16	16	16	16	16	128	128	128	128	128
...	...	...	...	11/64	...	...	...	...	2 1/8	...	...	...	...	17	...	...	...	...	136
...	...	...	9/32	9/32	...	...	...	2 1/4	2 1/4	...	...	...	18	18	...	...	...	144	144
...	...	...	...	19/64	...	...	...	...	2 3/8	...	...	...	...	19	...	...	...	...	152
...	...	5/16	5/16	5/16	...	...	2 1/2	2 1/2	2 1/2	...	...	20	20	20	...	...	160	160	160
...	...	...	...	21/64	...	...	...	...	2 5/8	...	...	...	...	21	...	...	...	...	168
...	...	...	11/32	11/32	...	...	...	2 3/4	2 3/4	...	...	...	22	22	...	...	...	176	176
...	...	...	...	23/64	...	...	...	...	2 7/8	...	...	...	...	23	...	...	...	...	184
...	3/8	3/8	3/8	3/8	...	3	3	3	3	...	24	24	24	24	...	192	192	192	192
...	...	...	...	25/64	...	...	...	...	3 1/8	...	...	...	...	25	...	...	...	...	200
...	...	...	13/32	13/32	...	...	...	3 1/4	3 1/4	...	...	...	26	26	...	...	...	208	208
...	...	...	...	27/64	...	...	...	...	3 3/8	...	...	...	...	27	...	...	...	...	216
...	...	7/16	7/16	7/16	...	...	3 1/2	3 1/2	3 1/2	...	...	28	28	28	...	...	224	224	224
...	...	...	...	29/64	...	...	...	...	3 5/8	...	...	...	...	29	...	...	...	...	232
...	...	...	15/32	15/32	...	...	...	3 3/4	3 3/4	...	...	...	30	30	...	...	...	240	240
...	...	...	...	31/64	...	...	...	...	3 7/8	...	...	...	...	31	...	...	...	...	248
1/2	1/2	1/2	1/2	1/2	4	4	4	4	4	32	32	32	32	32	256	256	256	256	256
...	...	...	...	17/32	...	...	...	...	4 1/4	...	...	...	...	34	...	...	...	...	272
...	...	...	9/16	9/16	...	...	...	4 1/2	4 1/2	...	...	...	36	36	...	...	...	288	288
...	...	...	...	19/32	...	...	...	...	4 3/4	...	...	...	...	38	...	...	...	...	304
...	...	5/8	5/8	5/8	...	...	5	5	5	...	...	40	40	40	...	...	320	320	320
...	...	...	...	21/32	...	...	...	...	5 1/4	...	...	...	...	42	...	...	...	...	336
...	...	...	11/16	11/16	...	...	...	5 1/2	5 1/2	...	...	...	44	44	...	...	...	352	352
...	...	...	...	23/32	...	...	...	...	5 3/4	...	...	...	...	46	...	...	...	...	368
...	3/4	3/4	3/4	3/4	...	6	6	6	6	...	48	48	48	48	...	384	384	384	384
...	...	...	...	25/32	...	...	...	...	6 1/4	...	...	...	...	50	...	...	...	...	400
...	...	...	13/16	13/16	...	...	...	6 1/2	6 1/2	...	...	...	52	52	...	...	...	416	416
...	...	...	...	27/32	...	...	...	...	6 3/4	...	...	...	...	54	...	...	...	...	432
...	...	7/8	7/8	7/8	...	...	7	7	7	...	...	56	56	56	...	...	448	448	448
...	...	...	...	29/32	...	...	...	...	7 1/4	...	...	...	...	58	...	...	...	...	464
...	...	...	15/16	15/16	...	...	...	7 1/2	7 1/2	...	...	...	60	60	...	...	...	480	480
...	...	...	...	31/32	...	...	...	...	7 3/4	...	...	...	...	62	...	...	...	...	496
1	1	1	1	1	8	8	8	8	8	64	64	64	64	64	512	512	512	512	512

quarters, etc., and therefore requires a system of preferred numbers based upon these fractions. The semi-geometric series advocated by the author is based on these very fractions, but is open to criticism by advocates of pure geometric series on the ground that it is a mixture of arithmetical progressions with a geometric series. These critics hold up the European series as a good example of pure geometric progression, but neglect to notice that the arbitrary rounding off of terms to give practical values actually transforms the European series into a haphazard arrangement of arithmetical progressions, as is evidenced by the following ranges of values culled from Table 3:

2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5, 6

26, 28, 30, 32, 34, 36, 38, 40, 42, etc.

On the other hand, the proposed semi-geometric series makes use of interpolated arithmetical progressions, already conceded in principle by the approximations in the European series, in an entirely logical manner as is illustrated by Fig. 1, which shows that the curved lines representing arithmetical progressions touch the straight line representing pure geometric progression at regular intervals which are values of the first order of preference of the proposed standard.

Mathematical analysis will show that the proposed standard follows very closely a geometric progression having a ratio of $\sqrt[40]{10^3}$. For this reason many advocates have suggested the series $\sqrt[40]{10^3}$ as the ideal series for American industry, but the author contends that the proposed standard is more in accord with American practice. Incidentally, it is interesting to note that the first order of preference expressed as dimensions in inches and converted into metric equivalents in millimeters checks very closely with the European primary series, as is shown in Table 4.

TABLE 3 GERMAN SERIES OF PREFERRED NUMBERS (SIMPLIFIED VALUES)

Values from 1 to 48				Values from 50 to 500			
Series 1	Series 2	Series 3	Series 4	Series 1	Series 2	Series 3	Series 4
1	1	1	1	...	50	50	40
...	1.2	1.2	1.2	...	...	...	52
1.6	1.6	1.6	1.6	...	...	56	56
...	2	2	2	...	...	...	60
2.5	2.5	2.5	2.5	64	64	64	64
...	3	3	3	...	...	...	68
...	...	3.5	3.5	...	...	72	72
4	4	4	4	...	...	...	75
...	...	4.5	4.5	...	80	80	80
...	5	5	5	...	...	...	85
...	...	5.5	5.5	...	...	90	90
6	6	6	6	...	...	...	95
...	...	7	7	100	100	100	100
...	8	8	8	...	...	...	105
...	...	9	9	...	...	112	112
10	10	10	10	...	...	...	118
...	...	11	11	...	125	125	125
...	12	12	12	...	...	...	132
...	...	...	13	...	...	140	140
...	...	14	14	...	...	...	150
...	...	...	15	160	160	160	160
16	16	16	16	...	...	...	170
...	...	...	17	...	...	180	180
...	...	18	18	...	...	...	190
...	...	...	19	...	200	200	200
...	20	20	20	...	...	...	210
...	...	...	21	...	...	225	225
...	...	22	22	...	...	...	240
...	...	...	24	250	250	250	250
25	25	25	25	...	...	...	265
...	...	...	26	...	...	280	280
...	...	28	28	...	...	...	300
...	...	...	30	...	320	320	320
...	32	32	32	...	...	...	340
...	...	...	34	...	...	360	360
...	...	36	36	...	...	...	380
...	...	...	38	400	400	400	400
40	40	40	40	...	...	...	420
...	...	...	42	...	...	450	450
...	...	45	45	...	...	...	480
...	...	...	48	...	500	500	500

This agreement is of course accidental, but indicates that the proposed standard might serve as a common meeting ground for American and European manufacturers.

TABLE 4 CONVERSION OF METRIC AND ENGLISH SCALES

Common Fractions, First Order	Metric Equivalents, Millimeters	European Primary Series, Exact	European Primary Series, Approximate
$^1/_{64}$	0.3969	0.39811	0.4
$^1/_{32}$	0.7938	0.79438	0.8
$^1/_{16}$	1.5875	1.5849	1.6
$^1/_8$	3.1750	3.1623	3.2
$^1/_4$	6.3500	6.3096	6.4
$^1/_2$	12.7000	12.589	12.5
1	25.4001	25.119	25.0
2	50.8002	50.119	50.0
4	101.6004	100.00	100.0

TABLE 5 QUANTITIES OF LIQUID EXPRESSED IN CONVERTED UNITS

Ounces	8	16	32	64	128	256
Pints	$^1/_2$	1	2	4	8	16
Quarts	$^1/_4$	$^1/_2$	1	2	4	8
Gallons	$^1/_{16}$	$^1/_8$	$^1/_4$	$^1/_2$	1	2

TABLE 6 RESULT OF SURVEY OF CONVERSION FACTORS

Order of preference	1	2	3	4	5	6	7	8	9	10	
Items in each order	24	20	16	14	8	4	1	0	0	1	(Total, 88)

As has already been mentioned, conversion factors for length, weight, area, volume, etc. must be considered in developing a series of preferred numbers. When a very wide range of sizes is involved, the smaller sizes are measured in units different from those used in measuring larger sizes, as is shown by the every-day practices of dimensioning machine elements in inches and telephone poles in feet. In dealing with conversion factors needed for American units the series was found to agree with the second of the desiderata formulated by Messrs. Hirshfeld and Berry. This desideratum, expressed in practical form, states that if a preferred number in ounces were used for the weight of a manufactured article, the same weight expressed in pounds ought also to be a preferred number. Table 5 illustrates very clearly the correlation between American units and the proposed American standard by expressing certain sizes of containers in ounces, pints, quarts, and gallons. It will be noted that, regardless of the units chosen, all the values are of the first order of preference.

The author extended the results of his investigation to include 88 conversion factors commonly used when dealing with American units of measurement, and found that the values of these conversion factors adhere closely to the preference of numbers as outlined in the semi-geometric series. This result is shown very clearly by Table 6, which lists the number of conversion factors that occur in the first ten orders of preference. Inspection shows that 74 of the 88 conversion factors occur in the first four orders of preference, and would therefore give numbers in these first four orders when used for converting other numbers originally chosen from these first four orders.

A sincere effort was made to apply the European series to the simplification and standardization of a number of existing American commodities, but the effort only confirmed the conviction that these series are not applicable in this country. For this reason and for the reasons enumerated above the author was led to the proposed standard, which has been called the semi-geometric series. This series is really a list of already preferred numbers because it includes all of the numbers that are commonly used in American industry. All of these numbers, however, are tabulated in such a manner that every-day preference for certain round numbers is clearly indicated. If, in designing a new object, all the dimensions were checked against the values in the semi-geometric series and a sincere effort were made to use only dimensions of the first, second, and third orders of preference, the designer would never have any need to standardize or simplify his product because the product would have been designed by the very laws that govern standardization and simplification. In short, the proposed American standard or semi-geometric series applies to the original design the laws that govern standardization and simplification.

Observations on Czechoslovakian Shop Practice

SHOP equipment is strangely varied. In one department you will find German tools that date from the war, or earlier. In the next will be some of the best precision and production machines. The largest buyer of machine tools in the country told me that when precision or high production was the requirement he bought American tools. For ordinary simple operations where high precision was not needed he used German ones because they were good enough and less expensive.

Belt drive is almost universally used. The Czechs are watching expenses closely and they believe that it is more important to save the cost of the extra current used by an individually driven machine at the expense of flexibility of arrangement and the interference of the belts with general lighting. Some thought has been given to artificial lighting, but not enough, I should say.

Material handling is embryonic. There are some electric trucks and in one shop I saw standard containers, but hardly a start has been made in progressive assembly. As to inter-machine transportation, that is yet to come.

Like the Swiss, many of the Czechs are wide travelers, and there is a fair sprinkling of engineers and production men with experience in American shops. They are making a strong effort to overcome old traditions and there is considerable progress to report. In one big plant, for example, they have adopted a standardized lathe tool patterned somewhat after the DeLeeuw and Klopstock designs with recessed top surfaces.

The scale of wages is certainly low but it is compensated for, in part at least, by the fact that most of the men have farms on which they can raise their own food with perhaps some surplus to sell.

This situation has been largely responsible for the hours worked in some of the plants. The largest one is running two shifts, six to two and two to ten. No time is taken out for lunch or any other meal, the men preferring to work steadily for eight hours and devoting the time saved to work on their farms. They keep going by carrying a roll or hunk of bread in a convenient pocket, munching on it whenever the occasion offers or hunger makes it imperative.

One of the unsolved problems is that of the transportation of the workers between farm and factory. A few go by train, others use bicycles, and I was told of one man who walked to work, three hours there and three hours back.

At one plant we had a little discussion on this matter of transportation, during the course of which I pointed out that an American mechanic could get a used automobile for as little as fifty dollars that could be tinkered into shape in his spare time and serve as a quick means of getting to and from work. My hosts asked how long it would take an American foreman to save up the necessary money to buy a car. I hazarded a guess that he might do it in two or three months, if he were not buying too many other things on the instalment plan. They estimated that it would take a Czech foreman 17 months to save the same amount, and stated positively that a workman would never save that much money in his whole working life.—*American Machinist*, vol. 69, no. 15, pp. 563–564.

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

AERONAUTICS

Plumbing Troubles

AS A CONTINUATION of Atlantic-flight attempts seems to be inevitable, one might as well take advantage of the situation and draw such conclusions as may be derived from analyzing the causes for the failure of the flights. Courtney's flight, Franco's flight, and the Polish flight were all three terminated by what is popularly known as "plumbing" trouble. In none of the instances cited was there any failure in the engines, but in all three cases the engines stopped through failure of the feed lines. The failure of Franco's four-engined Dornier plane was the most striking. Apparently all four engines quit at so nearly the same time that a hasty descent from a low altitude had to be made and the plane was very badly damaged. On investigation it was found that the gasoline pumping system had failed, and apparently even the best of engines will not run without gasoline. It would seem as if this should have been realized before and that an independent pumping system should have been in operation for each engine. Working out a system where each engine is independent of the other, yet at the same time can use the gasoline of any other engine, is not as simple as it sounds, but it certainly can be worked out.

In the case of the Polish fliers the oil system failed, but as the plane was wrecked it may be hard to ascertain exactly what happened. Apparently the failure was not in the pumping system but in the piping system, as there was an evident and large leakage of oil. In the case of Captain Courtney the failure was due to the breaking of the main gasoline feed line. Evidently either the material used was faulty, or what is more likely, it was so supported that it was subject to excessive strain, and failure was merely a question of time. In either case the danger of running gasoline lines through spaces enclosed by cowling and close to the exhaust was demonstrated.

The arrangement of feed lines is not an exact science and the stresses involved are not as calculable as those on a wing or crankshaft, but none the less it would seem as if enough experience has been gathered to prevent so many failures from such causes. Of course, all the planes in question were in a sense experimental, and the particular installation had not been tested in the tens of thousands of miles of flying which standard types run up. It is evident, however, that the arrangement of feed lines, especially for the new types of engines which are being brought out, is a matter which requires the greatest care, and it should not be left to the shop mechanic or even to most plane designers. To the flier the failure of a feed line is just as serious as the failure of a crankshaft, and if engine manufacturers care about the reputation of their product they should check carefully with the plane manufacturer the details of the engine accessories. (Editorial in *Aviation*, vol. 25, no. 9, Aug. 25, 1928, p. 589, *g*)

FUELS AND FIRING

Synthetic Motor Fuels in France and Germany

MANY references are now being made to the plant at Leuna, Germany, where lignite is plentiful and is treated direct without the intervention of hydrogen.

The material, carbonized at low temperatures, gives off from 60 to 130 kg. of various "essences," tars, and phenols from each ton. By fractionating, the tars produce both grades of essences, fuel oils, paraffins, and other products. A second distillation supplies "light" essence, lamp oils, oily acids containing phenols, fuel oil, lubricating oil, paraffin, etc. The product being therefore one of carbonization at low temperature and treatment of the tars by catalysis, it is not a synthetic gasoline in the proper sense of the world. The daily average production at present is said to be about 15 to 20 tons of petrol essence for each 100 tons of lignite. The extraction of lignites for last year was 139,000,000 tons. 30,000,000 tons of lignites would provide 2,000,000 tons of the new petrol.

In France the Houdry-Prud'homme method is at present being closely developed. The expense, including all costs whatever upon each ton of lignite, has been worked out at 101 francs. Against this there would be 30 liters of petrol spirit and 500 kg. of coke, with certain other residue products, from which the profits at present are uncertain. The coke and petrol gasoline might be worth 100 francs. The plant erected at Saint-Etienne-des-Peyrolas is for treating 100 tons daily, with the expectation of 3000 liters of "petrol" per day. Taking the density at 0.70, we may say this is just over two tons per day.

Under the auspices of a carbonization commission formed in 1922, and the National Office for Liquid Combustibles (which also includes the Société Nationale des Récherches des Combustibles), there is a laboratory near Creil studying the transformation of coal gas by catalysis. But M. Patart brought up the making of a synthetic alcohol—methylic—oxide of carbon hydrogenated with a catalyzer. Pressures of 150 atmos. are used with temperatures of 220 to 300 deg. In simple language it is a "water gas" enriched by hydrogen. One cubic meter of this gives 475 g. of methanol, which is equivalent to 225 g. of "essence." One kilogram of coal will supply 500 g. of methanol, and this will replace petrol essence in the proportion of one and a half liters of methanol for one liter of petrol (density 0.73). M. Patart puts the cost price of 100 kg. of methanol made on an industrial scale (density 0.8) at 130 francs, but not including some other outside charges. While the substitute is therefore of interest, it is not a commercial possibility; although, in case of emergency and if all possible resources contributed the methanol, there might be ample supplies of carburant "national." M. Dumanois considers the methanol "a carburant free from all criticism."

It is therefore evident that Germany is quite in a position to be independent of outside sources for the motor carburants, while France, in consequence of various circumstances, will still have to count upon petrol supplies from abroad. (*The Petroleum Times*, vol. 20, no. 496 (old series 1355), July 14, 1928, p. 60, *g*)

Partial Dehydrogenation of Fine Coal to Permit of Its Briquetting

IT HAS been previously shown by one of the two authors of the present article that fine coal containing a large amount of volatile matter may be formed into a substitute for anthracite by agglomeration and distillation at low temperature, provided the

binder used does not contain more than a very small amount of resinous matter. In the manufacture of briquets, however, their cohesion is due primarily to the binder properties of the resinous matter in the coal, and some cohesion in the material is necessary before the distillation process is carried out. One of the methods of obtaining this involves the use of sulphur, which dissolves in the tars and oils. The disadvantage of using this process is that a binder containing any appreciable amount of sulphur is objectionable as it is likely to attack the boiler furnace.

The present authors have found, however, that if hydrocarbons are subjected to a contact treatment with sulphur at a high temperature but only for a limited period of time, it is possible to dehydrogenate them partly without introducing an objectionable amount of sulphur in the final product, and that the tars and oils thus dehydrogenated are made capable both of adhesion and of drying. The process of operation is as follows: A tar, a fuel oil, or an oil obtained from coal is mixed with sulphur in the proportion of from 2 to 10.5 parts per hundred. This mixture is heated to temperatures and for periods of time indicated in the original article either in open air or in a closed vessel. In the latter case an estimate of the sulphur content in the mixture may be obtained from the volume of the hydrogen sulphide evolved in the course of the process. The free sulphur is isolated by precipitation by sulphuric ether at a temperature below 10 deg. cent. (50 deg. fahr.) and the content of sulphur in the residue of filtration is determined by the sodium hypobromide process. In all tests made at the high temperatures indicated below no free sulphur was found. Viscosity and drying ability (siccativity) are measured in each case before and after treatment. The Baumé viscosimeter cannot be used on account of the color of the tar; hence the viscosity is measured on an arbitrary scale by the duration in seconds needed for a glass rod 100 mm. (3.9 in.) long, 8 mm. (0.314 in.) in diameter and weighing 41.5 g. to sink in the liquid under its own weight. The siccativity or drying ability is measured by the time which elapses until a thin layer of the liquid on a glass plate ceases to stick to the finger. The author used for his tests a tar, a fuel oil, and an oil derived from coal with the results indicated in Table 1.

TABLE 1

Product treated	Treatment	Residue of sulphur, per cent	Arbitrary Viscosity At 15 deg. cent.	At 25 deg. cent.	At 50 deg. cent.	Drying time, hours
Tar	None		<1 sec.	....	....	80
	10 per cent sulphur at 250 deg. cent., 90 min.	0.65	3 hr. 20 min.[1]	5 min. 20 sec.	3 min. 17 sec.	12
Fuel oil	None		<0.50 sec.	....	....	>250
	10 per cent sulphur at 300 deg. cent., 90 min.	0.80	4 min. 28 sec.	6.3 sec.	<1 sec.	>250
			At 20 deg.	At 30 deg.		
Oil from coal	None		3.2 sec.	....	....	
	2 per cent sulphur at 350 deg. cent., 120 min.	1.12	9 min. 57 sec.	7.6 sec.	<1 sec	

[1] This is probably an error, and 3 min. and 20 sec. is meant. If this were not so the author would have called attention to the unusually long period. (EDITOR.)

As regards resinous matter in the oil, a clear increase in viscosity has been observed, but up to a temperature of 250 deg. cent. (482 deg. fahr.) the elimination of sulphuric acid is slight. As a conclusion, the authors state that it has been found to be possible to effect a partial dehydrogenation of tar, fuel oil, and oil from coal by sulphur without leaving in the final hydrocarbon product a proportion of sulphur greater than $^1/_{10}$ of one per cent by weight of the agglomerate. This dehydrogenation produces a considerable increase in the viscosity of the binder, this increase for tar being in the ratio of 1 to 12,000. Siccativity is likewise increased, and it is also claimed that the power of adhesion is increased. (André Léauté and Georges DuPont in *Comptes Rendus des Séances de l'Academie des Sciences*, vol. 186, no. 23, June 4, 1928, pp. 1558–1560, *e*)

HYDRAULIC ENGINEERING (See also Testing and Measurements: New Hydraulic Laboratory of the University of Iowa)

The Hofen Automatic Hydroelectric Power Station in Switzerland

THIS station forms part of the St. Gall Municipal Electricity Supply. It was built in connection with the settling plant of the St. Gall Switch Works and the settling tank serving the purpose of a reservoir holds 5000 cu. m. (176,572 cu. ft.) of water with a useful head of 3 m. (9.84 ft.). A total head of 83 m. (272.30 ft.) is available. A single 400-hp. hydraulic turbine is provided in the power station, and is designed for a volume of 400 liters (105 gal.) of water per second and a net head of 76.5 m. (250.9 ft.). The station is situated at a very inaccessible spot, which made it particularly desirable to convert the plant into one of the automatic type.

The conditions which had to be satisfied for this station were based on the quantity of water in the settling tank. With the normal inflow of water, the reservoir fills up to its maximum depth of 3 m. (9.84 ft.) in about four hours, and when the generating set is on full load it empties the reservoir down to the level of 1 m. (3.28 ft.) in about two and a half hours. The operation should therefore be such that when the reservoir is full the set will automatically start up in parallel with the network and remain connected up until the reservoir has emptied to a depth of 1 m. Since, however, under such conditions full utilization of the available electrical energy cannot be guaranteed during certain periods of the night, the plant should shut down at these times entirely independently of the water conditions.

The turbine in question is of the Francis type and is started up or shut down simply by operating the sluice valve. If this valve is slowly closed during normal service and the water supply to the turbine thus gradually cut off, the governor opens the distributer by a corresponding amount in an effort to keep the speed constant in spite of the reduced supply of water. If the turbine stops altogether in this way, its distributer will be fully open. Thus, if the sluice valve is slowly opened again in order to start up the set, the turbine can fill up to full speed at which it is kept by the governor. Like the turbine, the three-phase alternator is of quite a standard type. An integrally built exciter supplies current, for the generator fields, and regulation is obtained exclusively on the shunt circuit of the exciter. The essential features of the switching apparatus correspond to those usually adopted for hydroelectric power stations. Some additional apparatus is, however, required by the automatic operation.

The water-level remote indicator starts up or shuts down the power station; its pointer closes the circuits of the auxiliary relays when it reaches either of two adjustable positions, and thus operates the oil circuit breaker and the turbine sluice valve. The operation of these relays is controlled by a time switch, but the plant can be started up or shut down at will by means of an auxiliary switch. The temperatures of the different bearings are kept under observation by means of special protective devices. The

details of the action of the apparatus and the amount of saving derived are given in the original article.

From the financial point of view alone, automatic hydroelectric power stations are usually profitable. Combined with this there is the fact that, when disturbances occur, good relays undoubtedly work with a far higher degree of accuracy than can be expected from an attendant, and thus they afford better protection for the plant under all circumstances. Thus even where the installation of an automatic plant would not be financially expedient, it is well worth considering whether this should not be done in view of the increased reliability which would result. (U. Vetsch in *Brown Boveri Review*, vol. 15, no. 8, Aug., 1928, pp. 231–237, illustrated, *d*)

MARINE ENGINEERING

The World's Motor Shipbuilding

As SHOWN by figures collected by Lloyd's for a period of three months, the motor tonnage of ships now being built exceeds the steam tonnage by a greater figure than ever before recorded, namely, 363,081 tons. Compared with figures for a year ago the motor tonnage throughout the world has increased by 40,000 tons and steam tonnage decreased by 230,000. These figures are particularly impressive when referred to various countries.

A year ago oil engines of 1,102,424 i.hp. were under construction, and this figure has increased by about 250,000 i.hp. The power of turbines, on the other hand, has fallen from 338,000 s.hp. to 214,000 s.hp. (excluding Germany), and of reciprocating steam engines from 580,000 i.hp. to 492,000 i.hp. Russia shows a remarkable increase in oil-engine construction (from about 5000 i.hp. to 39,000 i.hp.), and in Japan the figures have jumped from 8000 i.hp. to 38,000 i.hp. In Germany, also, there has been a substantial increase, from 151,000 i.hp. to 227,000 i.hp., and in Denmark from 93,000 i.hp. to 137,000 i.hp.

More and more the oil engine is being adopted on larger and faster ships. In England at present there are only seven steamers with a tonnage above 8000 being built, while the number of motorships is 31. For the world as a whole there are 65 motorships above 8000 gross under construction and only 21 steamers. (*The British Motorship*, vol. 9, no. 101, Aug., 1928, pp. 186–187, 2 figs., and several tables, *s*)

POWER-PLANT ENGINEERING

The Design and Construction of High-Pressure Water-Tube Boilers

THERE are now installations in operation at pressures exceeding 1250 lb. per sq. in. which are said to be working satisfactorily. Still higher pressures promise a slight thermodynamic gain, but probably too little to justify much advance beyond that limit of pressure under present conditions.

Boilers of very large capacity, such as 300,000 to 400,000 lb. of steam per hour, are now operating, and there is a tendency to increase the rating of water-tube boilers for power-station work by reducing the steam-generating surface and recovering the heat from the waste gases by other means, such as air preheating. This has the advantage of cheapening the first cost of the installation by reducing the high-pressure, and therefore the most expensive, portion of the boiler equipment. Furthermore, the higher the steam pressure the higher the temperature of the water in the boiler, and therefore the larger the surface required to reduce the temperature of the gases as compared with a low-pressure boiler. For this reason also it is more economical from the point of view of capital cost to allow the gases to leave the boiler at a comparatively high temperature and recover the heat in other ways. In the case of burning pulverized fuel or oil there appears to be no limit to which the air may be heated, and therefore the most economical arrangement would be to recover the heat entirely by air preheaters.

As pressure increases, steam bubbles become smaller and the circulation tends to diminish. With high-pressure boilers it is therefore particularly important that every encouragement should be given to the water to circulate freely, and tubes well inclined and as straight as possible are preferable. Trouble has been experienced in water-cooled furnace walls due to faulty circulation. As boiler pressures increase it becomes more and more important to reduce—or if possible, eliminate—riveted and bolted joints, and to adapt drums or headers of a circular section. While forged drums are still more expensive than built-up drums, it is desirable to use forged drums with riveted ends at pressures exceeding 500 to 600 lb. per sq. in. At very high pressures, such as 1000 lb. and over, forged drums with closed-in ends can be used, rivets being then entirely eliminated.

Special reference is made to the method of manufacturing hollow-forged drums used by John Brown & Co., Ltd., Sheffield. Special care is taken in molding the metal and casting the ingot, which latter is properly cropped. When cold the ingot is cut to length and a hole of considerable diameter is trepanned through it, so that the center of the ingot is removed and it becomes possible to examine the ingot internally. In the forging operation the ingot is both expanded and drawn. In the case of drums with closed-in ends these are bored after the completion of the forging process, cut to length, and closed in. Particular care is taken in the closing-in of boiler ends to insure that deformation of the material takes place gradually. On the continent a large number of welded drums for high pressures are now being supplied. The effect of temperature does not worry the designer of the boiler but has a considerable bearing on the design of the superheater, and it is preferable to adopt reasonable steam temperatures at the superheater outlet and add, if necessary, further heat by reheating the steam at one or more stages during its progress through the turbine. The original article contains two very interesting tables (from tests by John Brown & Co., Ltd.) showing the effect of temperature on three different kinds of steel, namely, various carbon steels, a 3 per cent nickel steel, and a nickel-chromium steel. Taking into account the effect of "creep," it would appear from these tables that temperatures of 750 to 800 deg. fahr. are approaching the dangerous limit if ordinary carbon steel is used, but special steels will stand a higher temperature.

An interesting series of experiments was recently carried out at the works of Brown, Bayley, at Sheffield, to investigate the most suitable material for superheater tubes. Three samples were chosen: the first a nickel-chrome-iron alloy, the second a chromium-iron alloy, and the third ordinary mild steel. The experiments indicated that both the nickel-chrome-iron and the chromium-iron materials are highly immune to the attack of furnace gases, and are in this respect superior to ordinary mild steel. Tests were then carried out on the tubes by passing steam through them, entering at a temperature of about 750 deg. fahr., and leaving the tube at about 1000 deg. fahr., the temperature of the tube itself being kept about 1000 deg. fahr., by passing an electric current through it. The tubes of nickel-chrome-iron and of chromium-iron were found to be not attacked, although the experiments were continued for several weeks.

The result of the experiments with the mild-steel tube was, however, unsatisfactory. After a four hours' run a gas trap attached to the condensate outlet was found to contain a considerable proportion of hydrogen. Hydrogen was given off through the whole of this test but slowed up considerably toward the end, due to the heavy scale which formed inside the tube,

possibly making a protective coating and preventing the steam from further oxidizing the metal.

These tests proved the immunity of nickel-chrome-iron and straight chromium-iron alloys from oxidation, but the mild-steel tube, used as a basis of comparison, was immediately and continuously attacked. Assuming that such heat-resisting tubes can be manufactured at a reasonable price, it would enable higher steam temperatures to be used with safety. (H. E. Yarrow in a paper before Section G of the British Association, Glasgow, September 7, 1928; abstracted through *Engineering*, vol. 126, no. 3270, Sept. 14, 1928, pp. 341–342, 2 figs., *peA*)

In commenting on this paper Prof. A. L. Mellanby pointed out that there was a general opinion that it was possible to continue to increase the pressure and temperature and obtain increasing economy. That, however, was not the case. When one took into account the losses introduced by these high-pressure boilers, it would be found that within a certain limit of range there was very little advantage, and in his opinion many people today were using steam pressures which were higher than the investigations at present justified from the economic point of view. Some years ago Professor Kerr and himself read a paper on the subject, and they were attacked for recommending very high pressures. As a matter of fact, they were not recommending these very high pressures, but were simply stating what would occur, although at the same time venturing to predict that these high pressures would be adopted. There was some natural instinct in engineers to get the best possible, no matter what the cost, and there would always be found some engineers who, for the sake of the higher efficiency, would adopt the highest pressures. As a matter of fact, although there were a large number of high-pressure installations now in operation all over the world, he felt that there was a tendency to go beyond what economy dictated. The pressure problem was not so great as the temperature problem, the reason being that in dealing with very high temperatures the strength of the material diminished very rapidly as a certain temperature was exceeded by a degree or two. A rise of 10 deg. above the limiting temperature meant a considerable reduction in the strength of the material. Therefore the materials problem was the one which required most attention, and it was reassuring to know that there were so many metallurgists engaged upon it. The use of high temperatures and pressures would mean the saving of the steam engine and the steam turbine, but, following the motto of the Scottish Automobile Club, his advice was to "gang warily."

Sir Henry Fowler said that he had made several runs on the Schmidt-Henschel locomotive working at 900 lb. pressure. He found that there was economy in fuel consumption. He quoted several other high-pressure locomotives, but pointed out that the matter of high pressures in locomotive work was difficult, not from the technical side but from the commercial and economic side. If these high pressures were used a turbine must be employed, and on a locomotive its use involved many difficulties and a great deal of money.

Prof. F. C. Lea said that the important thing to know in relation to the use of high steam pressures and temperatures was what would be the strength of the material with time. Experiments had shown that a material which had a strength of 20 tons at, say, 500 deg. cent., after a time would have one of but five or six tons, and that was what was meant by the limiting creep stress.

As regarded special non-corroding and heat-resisting steels, even the best of them had shown by recent experiments that at a temperature of 800 deg. cent. they would have their strength reduced from, say, 15 tons to two tons in 53 weeks, and he had estimated that in one and a half years the strength would be reduced to 1 ton per sq. in. It was apparent, therefore, that above a certain limit, say, between 500 and 800 deg. cent. small changes of temperature meant very considerable changes in the limiting creep stress. (Discussion abstracted from *The Engineer*, vol. 146, no. 3792, Sept. 14, 1928, pp. 292–293, *ge*)

A British Water-Tube Boiler Installation

THIS is a description of the works of Taylor Bros. & Co., at Trafford Park, Manchester. An important feature is the very small space which the plant occupies. The actual floor area is 336 sq. ft. and the total height from ground level is 33 ft. The actual combustion chamber is 19 ft. high × 14 ft. 6 in. square, and yet an evaporation of from 80,000 to 100,000 lb. per hr. on a heating surface of 19,000 sq. ft. is obtained regularly. For the first time in England a solid-forged drum has been used in constructing the boiler. The circulation is positive and not subject to reversal, with sufficient flow to prevent stagnation and spitting, while a water level is maintained which at all the ratings will sweep the steam bubbles from the tube surface as fast as they are formed. Special arrangements have been made to prevent priming. The original article gives the results of tests, of which the following may be cited. The cost per ton of steam from and at 212 deg. fahr. is 260 lb. of coal burned, 3.05 kw-hr. of a.c., and a similar amount of d.c. current.

It should be stated that the demand for steam at Taylor Bros. works is of a very fluctuating character, as is indicated by some graphs which are not here published but which certainly show heavy variations in demand. In operating the plant, according to Mr. Watson Smyth, under whose supervision the plant has been in operation, endeavors are made to keep the CO_2 at a mean, in order to avoid running over with the wide fluctuations that had to be coped with, though as high as 15 per cent could easily be obtained. He also stated that it was essential that the coal used should be ground to a high degree of fineness and that it should be as dry as possible; the coal used on the boiler at Trafford Park was ground so that 80 per cent would pass through a 200 mesh.

The average test readings taken on the coal used are given as follows: 100 per cent through 40-mesh screen; 98 per cent through 100-mesh; 82 per cent through 200-mesh. Total moisture as fired, 2 per cent to 4 per cent.

In order to set up a whirling action the burner pipes are introduced tangentially into the combustion chamber so as to be tangent on an imaginary circle about 4 ft. in diameter.

The plant is operated by one boiler attendant, one boy, and one pump attendant per shift. For the purpose of starting up four small oil burners are installed, and it is found possible to ignite the coal starting from dead cold about five minutes after lighting the oil burners. The controls of the combustion apparatus are all electrical. (A. H. Hayes in *The Electrical Times*, vol. 74, no. 1920, Aug. 9, 1928, pp. 183–184, 3 figs., *d*)

A One-Man-Operated Central Station

ONE of the remarkable features about the design of the Avon Park Station owned by the Florida Public Service Co. is the fact that it can be actually operated by one man, notwithstanding its rated capacity of 15,000 kw.

The general features of design of the individual apparatus are standard. The plant is equipped with Allis-Chalmers turbogenerators utilizing steam of 400-lb. gage pressure at a temperature of 715 deg. fahr. There are two 1310-hp. rated capacity Casey Hedges bent-tube five-drum boilers. These boilers have a working pressure of 448 lb. per sq. in. and are operated at 428 lb. per sq. in. Combination convection and radiant superheaters are installed, the convection superheater being located behind the front bank of boiler tubes, while the radiant superheater is located in the front wall of the boiler above the burners.

The radiant-superheater elements are horizontal and the headers vertical. Steam passes in succession through the convection and radiant superheaters. This arrangement makes possible a very uniform steam temperature over a wide range of load and is expected to keep the temperature more uniform when the fuel is changed from oil to coal. In order further to compensate for the difference in superheat when changing from oil fuel to coal, provision was made for leaving out the four lower rows of elements of the radiant superheater at the present time while oil is used. It is expected that a reduction in superheat will occur when the fuel is changed from oil to coal.

At the present time fuel oil is used for fuel, but combination fuel-oil and pulverized-coal burners have been installed. Coal-handling equipment has not been installed, however, as yet.

The most significant feature of the plant is the arrangement made with the view to ease with which the plant could be operated. All of the equipment possible was located at one floor elevation. Equipment which could not be located on the operating floor was located in the basement and as far as possible in such a way that it could be observed from the operating floor. There are no dividing walls between the boiler room and turbine room, or between the turbine room and switchbay. In this way almost everything in the plant can be seen by a single operator in walking around the turbine.

The turbine room is 37 ft. wide and the turbine is placed lengthwise in the room. On the west side of the turbine room a 20-ft.-wide switchhouse, one story and basement, is provided for the 2300-volt cell structure, storage-battery set, motor-generator, and all electrical equipment. The space beneath this electrical bay in the basement is occupied by circulating water pumps, house service pumps and bleeder heater condensate pumps.

At the operating floor level only a platform on three sides of the turbine is provided, but at the end of the turbine toward the temporary end of the building an entire bay of the turbine room floor was provided. Here are located the main switchboard adjacent to the electrical bay, the boiler-control switchboard adjacent to the boiler room, and the operator's office and telephone booth. This arrangement makes the main switchboard and the boiler-control switchboard visible from a single position.

The same arrangements for ease in handling and reliability have been embodied in the station service layout and electrical control equipment. (R. D. Stauffer and J. P. Garden, Engineering Dept. of W. S. Barstow & Co., in *Electrical World*, vol. 92, no. 8, Aug. 25, 1928, pp. 349–357, illustrated, *d*)

A Method for the Prevention of Scale Accumulation in Boilers and the Like

THE author calls his method "non-chemical," because he makes use of colloidal phenomena which he does not consider as being chemical. Essentially, his method consists in treating linseed in an autoclave under steam pressure and thereby making a water extract at a temperature above boiling point. He claims that in this way only the carbohydrates are obtained, and that these are in the very fine state of division necessary for colloidal solution. He also claims that no oil is extracted by means of this equipment. These carbohydrates or matter extracted from the linseed are supplied to the boiler, and are said to adsorb any solid particle which is present in the water irrespective of its chemical composition. The author states that approximately 1 lb. of seed is required to every 2000 gal. of water, and that this system of treating does not give bare plates as at the junction of the boiler water and the plates the temperature is sufficient to destroy the colloid. A protective film of scale is formed but does not exceed $^1/_{32}$ in. in thickness.

In the discussion which followed, the author stated that a ship has been running with this apparatus in use for about two years, and that the apparatus has been specified for one of the largest power stations in England now being built. (A. T. Ridout in the *Transactions of the Institute of Marine Engineers*, vol. 40, July, 1928, original paper, pp. 333–340 and discussion pp. 340–350, *d*)

Modern Possibilities of the Lancashire Boiler

UNTIL quite recently the Lancashire boiler was looked upon as a "back number," and its elimination in favor of the water-tube type was regarded as being merely a matter of time. However, a very large number of batteries of Lancashire boilers in good condition are in operation in England, particularly in connection with collieries. Their replacement would mean an expenditure which many plants over there cannot afford. Lately a number of improvements have been introduced patterned largely on water-tube boiler practice, with the result that a new lease on life has been given to the Lancashire boiler.

Use of Low-Grade Fuel. This is an important problem for the colliery owner, as it would permit him to use unsalable slacks. Until about twelve months ago the problem of application of

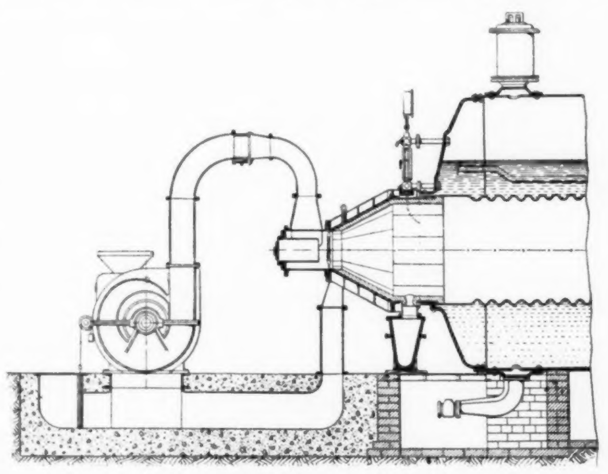


Fig. 1 Pulverizer and Burner Applied to a Lancashire Boiler

pulverized-fuel firing for internally fired boilers could not be said to have been solved in a really satisfactory manner, for although such boilers had been fired with this system the methods available involved application of a large external combustion chamber coupled with difficulties in connection with cooling of the tubular neck where the extremely hot gases left the chamber to pass into the boiler furnace flue. About a year ago an important advance was made by the application of the low-velocity system of powdered-fuel burning in which the flame extends something like 4 ft. from the burner. It is stated that there are some 70 colliery Lancashire boilers already equipped with this system in Great Britain. Fig. 1 shows such a short-flame burner as applied to a dish-ended colliery boiler. This burner is a so-called Holbeck made by Frazer & Chalmers Engineering Works, Erith. It projects into the stokehold space, is about 4 ft. 6 in. overall, and consists of a conical refractory-lined casing, the primary air being supplied with the fuel and heating the secondary air supply at the neck of the cone, so that the whole passes through a specially shaped serrated diaphragm, imparting a vigorous turbulent effect to the burning mixture. The secondary air keeps the refractory lining below fusion temperature and itself becomes preheated by circulation around the hollow external casing before it enters the burner. The firebrick lining

(part not shown in the drawing) is extended into the flue tube for about 10 ft. on the lower portion and for about 4 ft. on the upper side to form a combustion chamber and a suitable radiating surface to project the heat on to the heating surface of the flue crown.

Such burners may be used with either the compound pulverizing and blowing machine shown in Fig. 1, or may be supplied from a low-velocity fuel main on the Holbeck circulating system and central pulverizing and storage plant. (The original article shows a Lancashire boiler so equipped.) In Fig. 1 attention is called to the slag pot below the burner. This is the only slag which requires removal. Fine ash in the boiler flues is handled by means of soot blowers. Overall thermal efficiences of fully 80 per cent are said to have been obtained on Lancashire boilers of this type.

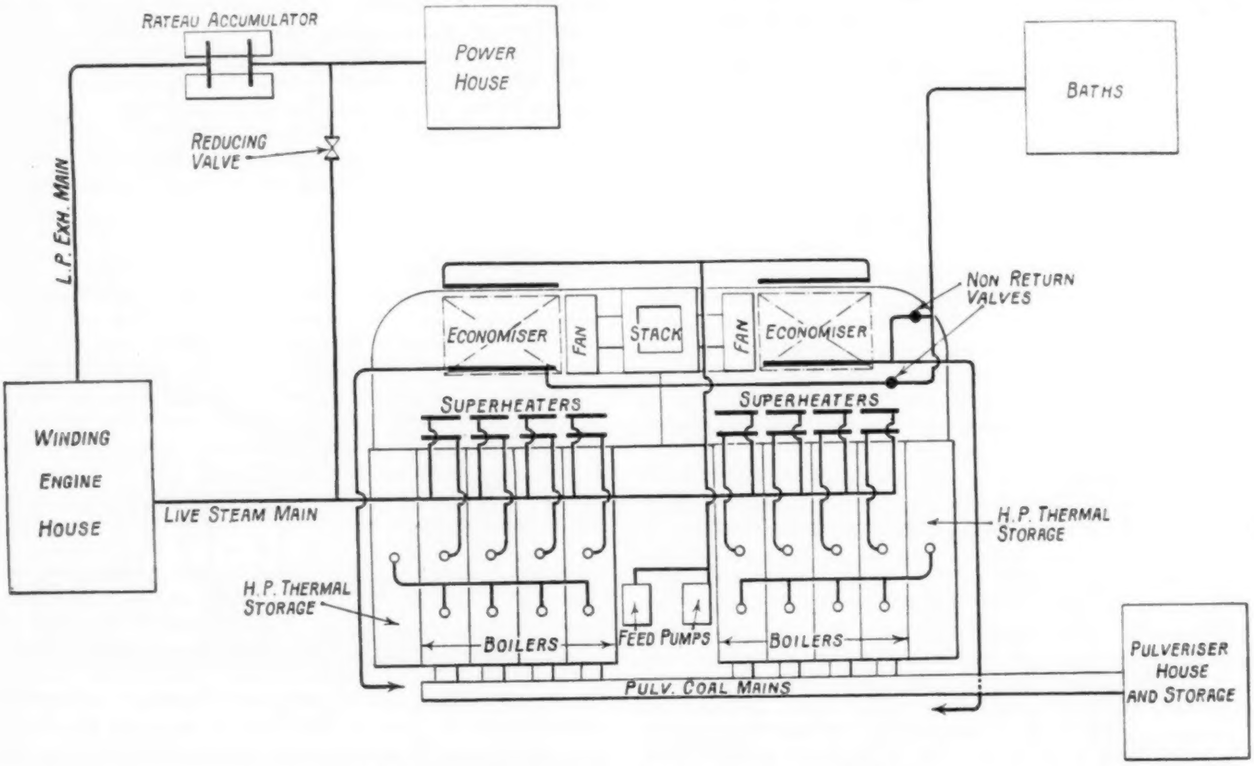


Fig. 2 Suggested Diagram of a Colliery Power Plant

The original article contains quite an interesting discussion of the problem of working economizers and superheaters in connection with colliery boilers. A figure in the original article shows an economizer which consists essentially of a number of gilled coils, so arranged that the gills on adjacent coils or pipes are staggered relatively to one another, thus breaking up stratification.

Steam Accumulation. What is probably the most serious factor operating against the very highest possible economy being realized is the greatly fluctuating load on a colliery plant. The author refers in this connection to the Kisselbach high-pressure thermal storage (for a description of this accumulator see Mechanical Engineering, vol. 49, no. 9, September, 1927, p. 1021).

Suggestions for a Typical Plant. The diagram plan, Fig. 2, is built up from a colliery plant well known to the writer and which consists of two groups of five Lancashire boilers each. At present there are no additional appliances beyond the economizers, and these have only recently been added. Tests have shown that the efficiency of this plant is still very low, although devices have been fitted in the downtake walls to stop the original short-circuiting which at first prevented the economizers being used on account of their boiling and hammering. Baths are not yet provided, but in the diagram such are shown with a tapping off the hot-feed main to supply their needs in this direction. The winding engine exhausts through Rateau accumulators to a low-pressure-turbine power house, with condensers and cooling towers. Although induced-draft fans are indicated in the diagram, these are not installed, neither would they, in this particular instance, be necessary, owing to the powerful chimney draft already available. Boiler dampers cannot be operated from the firing floor and are left fully open on all the working boilers. Only the stokehold is covered, the remainder of the boiler tops, steam and feed piping, etc., being unprotected and exposed to the atmosphere. Air leakage is severe, especially at the boiler fronts and at damper spindles and slots. To bring such a plant up to a high efficiency while using a low grade of fuel instead of the good-quality nutty slack at present hand-fired, the complete equipment shown in the diagram would bring about very great savings, equal, in the writer's estimation, to a saving of fully £3500 in fuel and about £800 per annum in labor, or £4300 ($20,500) per annum altogether. (Chas. F. Wade in *Colliery Engineering*, vol. 5, no. 53, July, 1928, pp. 271–274, 7 figs., *d*)

PUMPS

Pumps for High Pressure

In PUMPS for the generating of high-pressure water up to pressures of 3 tons per sq. in. the main point is simplicity provided that there are ample surfaces and strength of parts. The valve gear between the pumps and the machines to be driven

is the most difficult part in the design of the pieces. In this connection the author describes several types of valves used in British designs. The first is a gear made to drive an 1800-ton forging press from a pure hydraulic system consisting of accumulators and intensifier, and the valves are operated through relay cylinders. These cylinders are necessary because the load on the valves is too high to be hand manipulated, and the cylinders are fitted with a hunting gear which gives perfect control as between the hand lever and the press. In the accumulator pump the pressure is below 1 ton per sq. in. Pressures of 2 tons per sq. in. are used on some large accumulator systems but are exceptional. The general run of pressure is about 800 lb. per sq. in., because of the lighter load on pipes and joints required to convey the pressure water.

The original article shows views of a large accumulator pump and a small one, and some information is given on their design. In the large pump the valves have a very large diameter compared with the pump ram. In the case of a 100-hp. pump with rams $3^1/_2$ in. in diameter, the suction valve is also $3^1/_2$ in. in diameter and the delivery valve is $2^1/_4$ in., both having a lift of $^1/_8$ in. The large diameter in spite of the low lift gives the requisite area to enable the desired amount of water to pass. The low lift reduces the hammer effect of the valves on resuming their seats.

The valves are cylindrical, without wings, and the barrel design insures that the valve resumes its seat correctly, because the seat is integral with the guide, both being machined at the same operation. A further and important advantage is that the valve can be ground into the seat when on the bench before the pump is assembled, thus giving the opportunity to complete inspection; it also admits of rapid removal in case of repair, with reduced standing time, because the valve seating is not screwed into place, but usually held down by the screwed bonnets.

The valves and seats and also the rams are made of high-class phosphor bronze, but there is now an increasing demand for stainless steel or monel metal, both of which are very little greater in cost and more durable, with better wearing qualities. The pump barrels are of forged steel, bored out of the solid and fitted into the cast-iron yoke of the bedplate, thus eliminating any bolted joints.

With very small accumulator pumps, of 5 to 10 hp., often used on hydraulic balance systems for different classes of machinery, the pump barrels and valve chests of all the three rams are made in one piece, the cavities being drilled out of the solid. A plan view, Fig. 3, of such a pump (5-hp.) is given, having rams 2 in. in diameter by $2^1/_2$ in. stroke at a pressure of 750 lb. per sq. in., and running at 65 to 70 r.p.m.

A three-throw accumulator pump is next shown. It is exceptional in its lines, as in the main it conforms to a vertical three-throw engine. The pump barrels are carried in an entablature with a valve chest bolted to the ends and suction- and delivery-valve connections to suit.

The pump shown in Fig. 4 is of particular interest as it is really an entirely different style of pump and made for an entirely different purpose from that of an accumulator system.

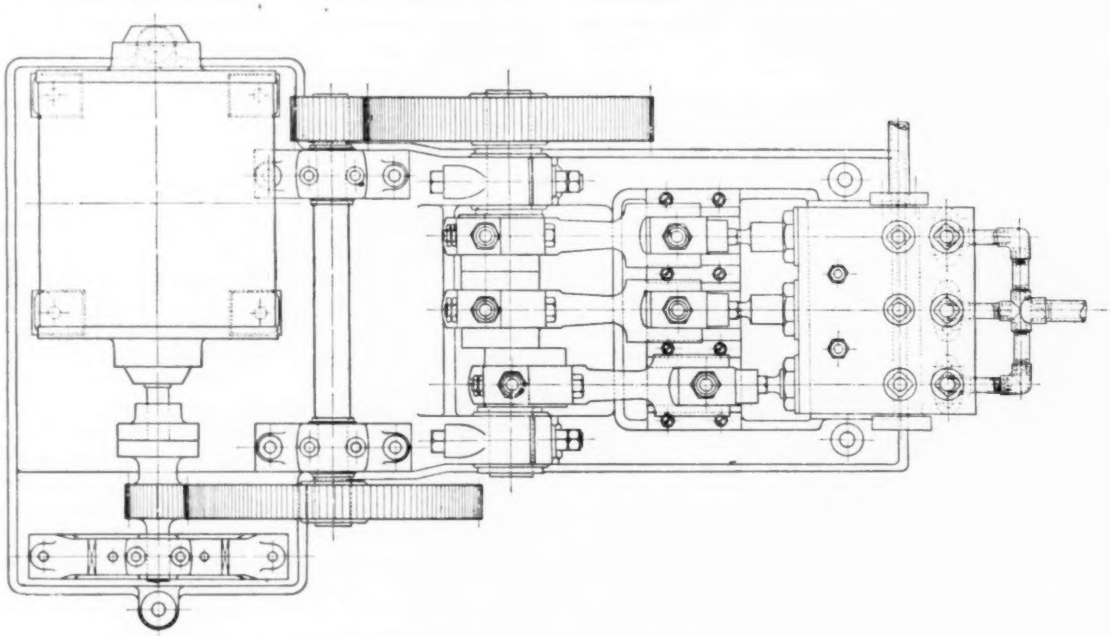


FIG. 3 SMALL ACCUMULATOR PUMP

The pump barrels and valve chests are in one piece of forged steel, rigidly bolted to and fixed between the bedplate legs, four in number, and the crosshead slides are supported similarly; this design of bedplate eliminating bending stresses and inducing direct tension. In some very large units the countershaft is built up, the webs and crankpin being one piece and the journal pins separate forgings, machined, shrunk in, and pinned together, similar to rolling-mill-engine crankshafts.

When this type of pump is used on press systems requiring long strokes, such as in bending presses or in pump-driven shears which occasionally are inquired for, the pumps are similar in design to the accumulator type, but the speed is 50 per cent faster because there are always load variations; whereas with accumulator systems the working pressure is always the maximum.

In one system of driving a large armor-plate bending press, the pumps, which are driven by a 250-hp. motor, gave a speed of $^1/_2$ in. per sec. on 8000 tons, but the motor was operated by a Ward Leonard control, giving speeds from creeping up to a maximum. In this case the pump motor was coupled direct to the crankshaft, but in all other instances there has been a set of double-helical gearing, as shown in the illustration.

For driving high-speed forging presses by means of electric pumps the high-speed flywheel in the illustration is requisite to give the peak load required for the work.

Taking as an example a 2000-ton forging press, it is necessary to fix upon the duty of the press. A customary schedule of operations is 8 full-load strokes per min., each stroke, being at the rate of 2 in. per sec. through 5 in., or a total time of penetration of $2^1/_2$ sec. For this purpose the pumps would need to have three rams $4^1/_4$ in. in diameter and 30 in. stroke, running at 100 r.p.m. to give the necessary speed on the press. To drive this pump a motor of 600 hp. would be required, and this would need the assistance of a flywheel weighing 10 tons with a diameter of 9 ft. 6 in., running in bearings 8 in. in diameter by 24 in. long, of the ring-oiled type and having not less than two rings. The double-helical gearing for such an equipment would be $1^1/_4$ diametral pitch by 24 in. face, with a wheel 6 ft. 3 in. in diameter.

In this particular type of pump—and in many pumps with an accumulator service—there are air vessels on the suction side having a pressure of 40 lb. to 80 lb. per sq. in. to insure no loss of speed in operation of the press, and this has the added marked advantage of keeping the suction-valve sizes down, because the water will pass the valve at high velocity, probably in the region of 10 ft. per sec.

The author next refers to special pumps used in isolated plants in India for the baling of cotton. This type has twelve rams, all running together up to a pressure of 0.75 ton. At that point by means of an automatic valve eight of the rams are put out of operation, and the final squeeze of the cotton, requiring a pressure of 3 tons per sq. in., is obtained by the remaining four rams. (R. H. Roberts in *Mechanical World and Engineering Record*, vol. 84, nos. 2169 and 2170, July 27 and Aug. 3, pp. 75–77 and 106–107, 7 figs., *d*)

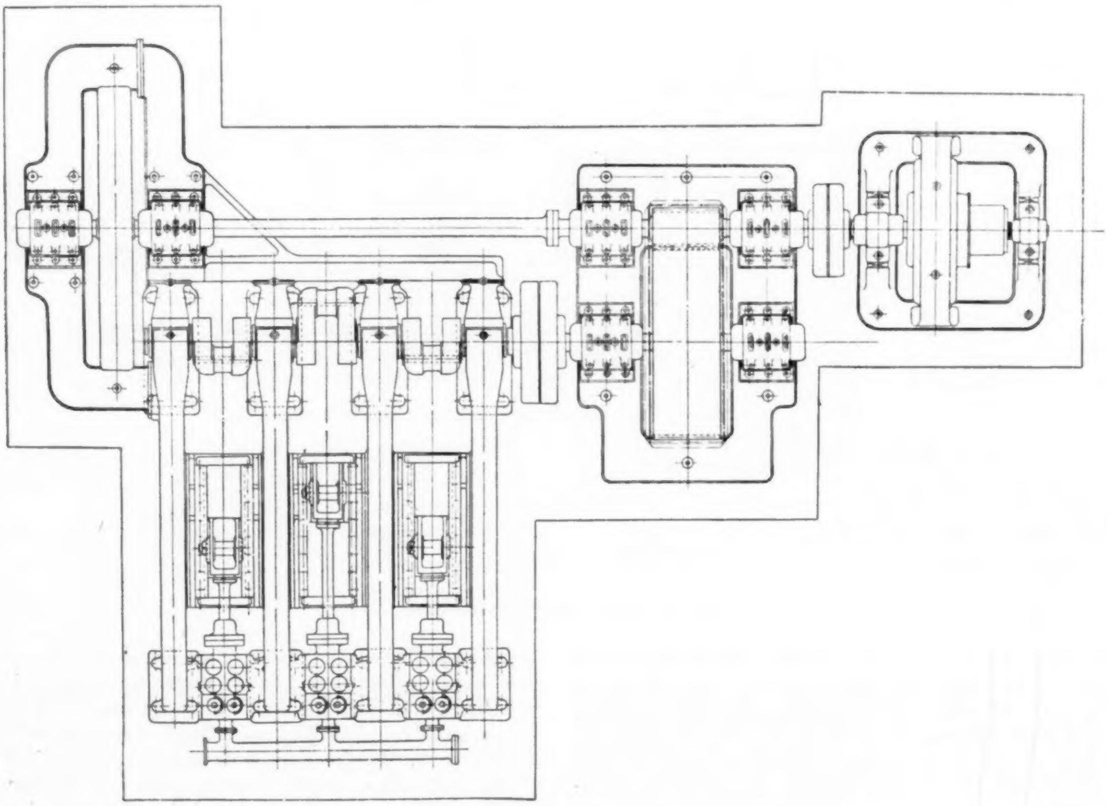


FIG. 4 DUNCAN STEWART & CO. PUMP FOR HIGH PRESSURE

RAILROAD ENGINEERING

The Race Between the Rail With the Locomotive

AFTER giving a brief historical sketch of the development of the rail and weights of locomotives, the author proceeds to discuss the present rail design and the reasons usually cited for the use of heavier rails. He quotes in this connection a statement by C. A. Morse, chief engineer of the Chicago, Rock Island & Pacific.

In 1910, the Rock Island had 1306 locomotives, with an average weight on drivers of 60.69 tons, and an average tractive power of 26,690 lb. In the same year, the gross ton-miles of freight-traffic on that road amounted to 5,598,000,000, with a freight locomotive mileage of 17,512,000. In 1926, by coincidence, the Rock Island again had 1306 locomotives, but the average weight on drivers had advanced to 83.85 tons, an increase of 38 per cent, and the average tractive power to 38,182 lb. an increase of 43 per cent. In the latter year these 1306 locomotives made a total mileage of 17,372,000, slightly less than that made by the same number of locomotives in 1910, but the gross ton-miles of freight traffic amounted to 8,317,000,000, an increase of 50 per cent. In 1910 the heaviest rails on the Rock Island weighed 85 lb. per yd. In 1911 the laying of 100-lb. rails was begun on the heaviest-traffic lines, and in the following year 90-lb. rails were introduced on the lighter main lines. At the end of 1926, 1202 miles of 100-lb. rails and 1362 miles of 90-lb. rails had been laid, the remainder of the 8000 miles of main track being laid with rails weighing 85 lb. or less per yard. The first 110-lb. rails were laid in 1927, and

beginning with the 1928 program, all new rails are to be of the 110-lb. R.E. section.

In the design of modern rails, a determined effort is made to secure greater girder strength so as to obtain a greater stiffness. In this connection the author quotes a passage from the book, "Economic Theory of the Location of Railways," by the late A. M. Wellington, as follows:

"In buying rails we are not buying steel; at least we do not care to buy it. We are buying three imponderable qualities: (1) stiffness; (2) strength; (3) durability. If we get our money's worth of these qualities, it is a matter of complete indifference (except for the future scrap value of the steel, which a poor, light-traffic road cannot afford to give much thought to) whether we get much or little of steel. If we do not get our money's worth of what we want, our bargain is just as bad, however much steel we get." He then went on to analyze the relative stiffness of rails ranging in weight from 10 lb. to 80 lb. per yd. and showed that, based on the quality of stiffness, the value received for each dollar expended for 80-lb. rail is 60 per cent greater than that expended for 50-lb. rail, or in other words, that the sacrifice in buying light rail was the same as if, in buying rails, one were in fact, as well as in form, buying steel instead of stiffness and were to choose 50-lb. rails at a price of $30 per ton (the price prevailing at that time) in the face of a price of $18.75 a ton for 80-lb. rails. Similarly, with respect to ultimate strength, he showed that the comparative value received for each dollar was 26.5 per cent greater for 80-lb. rails than it was for 50-lb. rails, and also that the heavier weights were more economical from the standpoint of durability.

While the design of rails and the loading of locomotives has been changed since the time the book was written, many engineers even today feel that still greater girder strength is needed, and for this reason recommend the heavier sections to provide that strength.

The author gives a list of roads which have recently passed to heavier sections, and he adds that few of the roads which have recently changed to heavier rails contemplate any further changes in the immediate future. The Kansas City Southern, however, will install 10-mile experimental sections of 115-lb. and 127-lb. rails of the Dudley section. The main reasons advanced for adopting heavier rails include the expectation of a reduction in maintenance-of-way expenses, increased life of the rail, reduction in rail failures, and an improvement in track conditions. It is claimed, for example, that on the Canadian National, a substitution of 100-lb. rails for 85-lb. rails showed a saving of about $100 per mile per year in maintenance cost. On the Northern Pacific the condition of 130-lb. rails which had carried traffic for three years on sharp curves indicated that they would be in service another three years before it would be necessary to replace them, while 90-lb. rails on the same curves usually lasted only 18 months.

Further improvements in rails are, however, desirable. The principal deficiencies cited in present-day rails include a predisposition to transverse fissures and other internal defects; softness of the material, resulting in excessive wear on curves as well as battering and chipping; and lack of uniformity in the quality of the steel. The chief engineer of a large western road says that the greatest need is stronger joints. The Kansas City Southern and the Nashville, Chattanooga, and St. Louis are or have been experimenting along these lines.

With respect to specifications, it is found that most of the larger roads are using those adopted by the A.R.E.A. in 1925, and feel that they have resulted in an improved quality of rail. The provision that all three test pieces must withstand the drop test, and the segregation and marking for identification of the A rails and those with high and low carbon content, are especially commended as contributing to safety and to greater service life. As a means of eliminating the disproportionately large number of rail failures from A rails, the Santa Fé, the Canadian National, and the Great Northern have modified these specifications by the elimination of A rails entirely, taking in their stead an equivalent tonnage of tie plates rolled from that portion of the ingot from which the A rails would be obtained, while other roads contemplate adopting the same practice. It is the custom of numerous other roads to confine the use of A rails to lines of slow or light traffic, although some of the roads are experiencing difficulty in finding sufficient places of this character to provide for the tonnage of these rails which they receive. L. C. Hartley, chief engineer of the Chicago & Eastern Illinois, reports that since that road has few curves, it is possible to provide high-carbon rails for practically all of them.

Special specifications of some of the other large roads are cited. The Northern Pacific installed some Sandberg sorbitic rails on sharp curves in its mountain territory in 1924, and an inspection made three years later showed that the loss of metal by abrasion, as well as the flow of metal on the low side, had been considerably less than in the case of open-hearth rails on similar curves carrying the same tonnage. The Kansas City Southern also reports similar results with the use of Sandberg sorbitic rails on curves of five degrees and over. (*Railway Engineering and Maintenance*, vol. 24, no. 8, August, 1928, pp. 328–335, illus., *gcA*)

REFRIGERATION

Flow of Brine in Pipes

IN ALL applications of refrigeration involving the circulation of brine, a knowledge of the magnitude of the frictional losses is essential to the economical selection of pipe sizes. The optimum size of pipe is that one which strikes an economic balance between cost of material, cost of installation, and cost of power required to overcome frictional resistance. The calculation of frictional resistance involves the use of a friction factor, the value of which must be determined for any given set of conditions. A definite relation exists between the friction factor and a ratio known as Reynolds' number. This ratio is a function of the dimensions of the pipe, the average velocity of the fluid, and the density and viscosity of the fluid.

The principal object of this investigation was to determine the relation between the friction factor and Reynolds' number when commercial calcium chloride brine is circulated in standard wrought-iron pipe under the conditions encountered in refrigeration practice. A secondary object was to determine the viscosity of commercial calcium chloride brine.

The author begins with the Darcy formula for the loss of head in the turbulent-flow range, and gives also an expression for the head loss due to friction in terms of pounds per square foot instead of feet of fluid. He next introduces the Reynolds number, and by utilizing the relationship between the friction factor f and this number, shows how results of experiments with any fluid may be used to determine the loss of head which will be encountered by any other fluid flowing in pipe lines having the same relative roughness.

The substantiation of the experiments of Stanton and Pannell on the flow of water and air in hard-drawn brass pipe by the work of Saph and Schoder on the flow of water in similar pipe has given a definite relation between the friction factor and Reynolds' number for this kind of pipe. This relation is shown in Fig. 3 in the original article. For the same abscissa value, the brass pipe in all cases of turbulent flow shows a smaller value of the friction factor than does the wrought-ion pipe. This is consistent with the relatively smooth inner surface of brass pipe. Almost exact agreement exists in respect to the value of Reynolds' number at which turbulent flow changes to streamline flow.

From a compilation of the results of various investigations of the friction of fluids other than brine flowing in steel, wrought-ion, and cast-iron pipes, McAdams has proposed a single curve to represent flow in pipes of this nature. This curve is reproduced in Fig. 3. In commenting on this curve, and on the curve of brass pipe, McAdams states, "It would be interesting to obtain test data for the friction of brine solutions in pipes of commercial refrigerating equipment of the closed type in order to determine which curve applies." It may be noted from Fig. 3 that the proposed curve of McAdams is in fairly close agreement with the results of this investigation. The values of the friction factor from the experimental results are slightly lower than those obtained from the proposed curve, particularly for smaller values of Reynolds' number. The proposed curve is a composite of the results of a number of investigators, and probably included some data from experiments made on pipe having rougher surfaces than the surface of the commercial wrought-iron pipe used in this investigation.

As a result of this investigation the following conclusions may be drawn:

1 The general theory of flow which involves the expression of the friction factor as a function of Reynolds' number is applicable to commercial calcium chloride solutions flowing in pipes.

2 The curve established for the flow of brine in commercial wrought-iron pipe is slightly lower than, but in close agreement with, the mean curve established by other investigators for the flow of air, steam, water, and oil in clean steel and cast-iron pipes. (Richard E. Gould and Marion I. Levy in *University of Illinois Engineering Experiment Station Bulletin* no. 182, 24 pp., 6 figs., *e*)

SPECIAL MACHINERY

Continuous Sheet Rolling

THE present article describes in some detail the rolling of sheets at the Ashland, Ky., plant of the American Rolling Mill Company, and covers the entire operation from molten pig iron to finished rolling. The most interesting part, from the point of view of mechanical engineering, is that dealing with the energy consumption of the mill.

The Ashland plant has been able to operate at nearly capacity output at all times and thus maintain a very desirable load for the Appalachian Electric Power Company, from which it purchases energy. During 1926 the plant had an average monthly energy consumption of approximately 3,950,000 kw-hr. with an average maximum fifteen-minute demand of about 11,150 kw. This corresponds to an average load factor for the year of about 49 per cent, which is considered exceptionally good for a plant of this nature. The average power factor was 86 per cent. For the first eleven months of 1927 the average monthly consumption has been nearly 5,250,000 kw-hr., which reflects the material increase in output over previous years.

Methods are constantly being improved, and developments which increase the capacity of the plant are still being made, so that the capacity of the plant has not as yet been determined. A month after being placed in operation the plant was turning out 350 tons of sheets per day. Now, after four years of operation, outputs up to 1400 tons per day are being produced. The ten-hour-turn record to date for the blooming, bar-plate, and jobbing mills is 162 11,000-lb. ingots, corresponding to nearly 1600 ingot tons per day of two turns.

Obviously, the unit energy consumption varies for different products and for various conditions of rolling. In a table in the original article are presented data showing the average gross monthly output of each department, with the corresponding unit energy consumption of each class of electric service.

The contract under which electric power is purchased specifies a penalty for average power factor below 85 per cent and a corresponding bonus if the average power factor is maintained above 90 per cent. It is therefore desirable to keep the power factor at as high a value as possible, and considerable attention has been paid to means for improving the power-factor conditions.

An interesting feature of the cold strip mill is the motor-driven screwdown on each side of each stand. The motors are geared 500 to 1 and the screws are of 0.25 in. pitch, so that one revolution of the screwdown motor moves the roll up or down only 0.0005 in. This fine adjustment is desirable in order to permit finishing straight strips of uniform thickness.

The plant operates a cold strip mill consisting of five stands of four-high rolls driven by direct-current adjustable-speed motors. The movement from mill to mill throughout the plant is almost entirely conducted by means of motor-driven roller and chain cables.

Forty-two electric cranes with a combined lifting capacity of about 1200 tons are used in the blast furnace, open hearth, and mill sections. For handling trailing loads up to about 10 tons between buildings there are three 3-ton and nine 2-ton storage-battery locomotives. In the shipping department there are three storage-battery trucks with 10-ton lift tables. These trucks are quite compact and easily operated, so that the sheets are carried directly into the railroad cars and packed with very little manual work. (T. J. Flaherty, Electrical Superintendent, American Rolling Mill Company, Ashland, Ky., and A. F. Kenyon, General Engineer, Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa., in *Electrical World*, vol. 92, no. 3, July 21, 1928, pp. 103–107, illus., *g*)

SPECIAL PROCESSES

The Sinking of a Coal Mine by the Freezing Process

THE PRACTICE here described was employed in sinking the Londonderry colliery in County Durham. In the past it had been usual to pass the cold solution through all the borings simultaneously from the beginning of the freezing. The ice wall grew slowly around each freezing tube until the cylinders of ice joined together. In this case on the contrary only two borings were put into circulation at the start—one on the western side of the shaft, and the other on the eastern side. These two borings were the only ones in circulation until the temperature of the four adjacent holes was found to be sufficiently low. Then these four holes also received the cold solution, thus making a total of six. In the same way the next four holes were brought to receive the cold solution, and so on, until all the borings were in circulation, the ice wall meanwhile growing in four different directions until it finally joined in two places. Among the advantages of this method of proceeding the following may be mentioned. When the last freezing tubes are put into circulation, there is absolute certainty that the ice wall is completely closed; it is possible to ascertain the disposition of the frost in the ground and to alter it, if necessary. An ingenious device was employed to control the distribution of the coldness in the various borings. The method used also made it possible to obviate some of the difficulties due to the presence of brackish water and salt in solution. (J. L. Henrard and J. T. Wheatton, in *Iron and Coal Trades Review*, vol. 17, nos. 3149, July 6, 1928, pp. 1–2, illustrated, *d*)

TESTING AND MEASUREMENTS

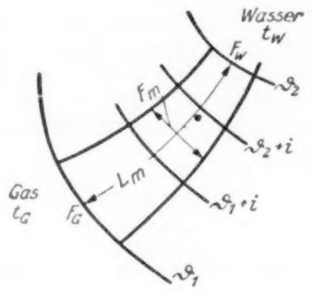
New Hydraulic Laboratory of the University of Iowa

AT IOWA CITY, the first section of the new University of Iowa hydraulic laboratory on the Iowa River is nearing completion. This section, 30 ft. wide and 60 ft. long, designed

to allow for future extension to an ultimate length of 150 ft., will be one of the finest and most complete hydraulic laboratories in this country.

Two motor-driven centrifugal pumps with a capacity of 3000 g.p.m. each will supply water to a constant-head supply tank on the top floor. This tank, with a weir length of 724 ft., will give a variation in head of less than 0.03 ft. from minimum to maximum flow.

On the second floor will be a tilting hydraulic tank 50 ft. long and 10 ft. wide for model testing or similar work, and a 3 × 3-ft. glass model flume 50 ft. long, the only one of its kind in America. On the lower floor two 20,000-lb. weighing tanks will be located, with the piping arranged so that the water can be weighed and discharged to volumetric measuring basins if desired. For large-scale experiments with heads up to 10 ft., the large 10 × 10-ft. river flume, which was already in place, has been increased



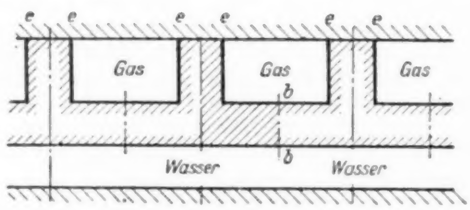


FIG. 5 LINES OF FLOW OF TEMPERATURE AND HEAT
(*Wasser* = water.)

FIG. 7 CROSS-SECTION OF A WALL THROUGH WHICH THE FLOW OF HEAT AND TEMPERATURE IS DETERMINED
(*Wasser* = water.)

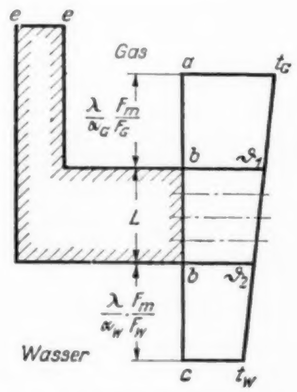
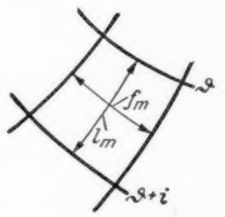


FIG. 8 DIAGRAM SHOWING THE METHOD USED IN PLOTTING THE CURVES SHOWN IN FIGS. 5 AND 6
(*Wasser* = water.)



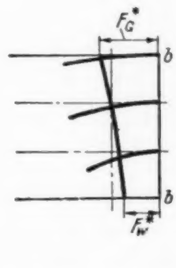


FIG. 6 AN ELEMENT OF THE NETWORK OF LINES USED IN DETERMINING FLOW OF HEAT AND TEMPERATURE IN WALLS

FIG. 9 FAIRING OF PLOT OF THE FIRST PATH OF HEAT FLOW

in length to 190 ft. The river divides the campus, and the University owns the dam and water rights.

At one end of the dam, the new power house, utilizing the river flow for hydroelectric power and condenser cooling water, has been built and, at the other end the new hydraulic laboratory is under construction. With the exception of the architectural details, the arrangement and design of the laboratory were under the direction of Prof. Floyd Nagler, assistant professor of hydraulic engineering. (*Power Plant Engineering*, vol. 32, no. 16, Aug. 15 1928, pp. 873–874, 1 fig., *d*)

THERMODYNAMICS

Heat and Temperature Distribution in Walls of Whatever Shape

THIS is an attempt to establish a graphical method of determining the flow of heat in walls independently of their shape. It is quite often difficult and at times impossible to determine by calculation the flow of heat in walls. The problem may, however, be more or less approximately solved graphically, and to do this the path of flow is covered by a network of temperature and heat lines of flow of such a character as to satisfy the conditions prevailing on the gas and water surfaces.

In Fig. 5 several isothermal lines are plotted at intervals of i deg. fahr. In the notation employed in that figure t_G is the temperature of the gas, ϑ_1 the wall temperature on the gas side, ϑ_2 the wall temperature on the water side, and t_W the temperature of the water.

The heat flows from the hotter to the colder side, which in this case is from the gas side to the water side, and the direction of the flow of heat is given by the heat-flow lines. These should be so plotted that the same amount of heat Q flows through each path of flow denoted by two consecutive lines. The lines of temperature and the lines of flow intersect at right angles. In investigating the flow of heat the following matters have to be determined.

1 *The Transfer From the Hotter Medium to the Wall.* If F_G is the cross-section of the path of flow on the gas side, and α_G the coefficient of heat transfer, then

$$Q = F_G \, \alpha_G \, (t_G - \vartheta_1) \ldots\ldots\ldots\ldots\ldots\ldots [1]$$

2 *The Heat Conduction in the Wall.* If λ denotes the conductivity, F_m the average cross-section of the path of flow, and L_m the average length of the path of flow, then

$$Q = \lambda \frac{F_m}{L_m} (\vartheta_1 - \vartheta_2) \ldots\ldots\ldots\ldots\ldots\ldots [2]$$

If we consider a unit of the system of heat and temperature lines taken at random (Fig. 6) and consisting of two consecutive lines of flow and two temperature lines ϑ and $\vartheta + i$, then

$$Q = \lambda \frac{f_m}{l_m} [(\vartheta + i) - \vartheta] = \lambda \frac{f_m}{l_m} i \ldots\ldots\ldots [3]$$

Since Q, λ, and i must be constant, it is obvious that the ratio f_m/l_m may have the same value for all units. For the sake of simplicity let it be assumed that the projection of f_m on the

plane of the drawing is equal to l_m. If this is so, then the average length of all the meshes in the net work will be equal to the average width thereof.

3 *The Heat Transfer From the Wall to the Colder Medium.* If F_W denotes the cross-section of the path of flow on the water side and α_W the coefficient of heat transfer, then

$$Q = F_W \alpha_W \, (\vartheta_2 - t_W) \qquad [4]$$

The following simple example will show how temperature and flow lines are plotted on the above basis. Fig. 7 gives the dimensions of a cast-iron body in which the sections *e-e* are impervious to heat. The gas temperature is 130 deg. cent. (266 deg. fahr.) and the water temperature 30 deg. (86 deg. fahr.). Further, $\lambda = 55$, $\alpha_G = 260$, and $\alpha_W = 1250$ kg-cal. per sq. m. per hr. per deg. cent. For reasons of symmetry only the hatched part of the section in Fig. 8 will be considered. The plotting of the network of lines is started at the line *b-b*, because this is a

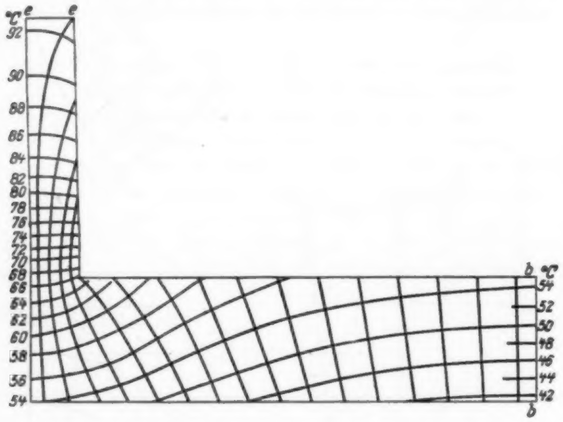


FIG. 10 NETWORK OF LINES OF FLOW AS ULTIMATELY ARRIVED AT

flow line and the temperature lines are normal to it. The first thing is to determine the temperature line *b-b*. To do this the lines *ab* and *bc* are plotted in Fig. 8. Their lengths are

$$\overline{ab} = \frac{\lambda}{\alpha_G} \frac{F_m}{F_G} \quad \text{and} \quad \overline{bc} = \frac{\lambda}{\alpha_W} \frac{F_m}{F_W}$$

If we draw horizontal lines at points *a* and *c* and measure off on them t_G and t_W to an appropriate scale and connect the ends of these lines, then the horizontal line drawn from point *b* to the line $t_G \, t_W$ will show the temperatures belonging to these points. It will be noted that according to Equations [1], [2], and [4],

$$Q = F_G \alpha_G \, (t_G - \vartheta_1) = \frac{\vartheta F_m}{L} (\vartheta_1 - \vartheta_2) = F_W \alpha_W \, (\vartheta_1 - t_W)$$

where L is the length of the path of flow; from this it follows that

$$(t_G - \vartheta_1) : (\vartheta_1 - \vartheta_2) : (\vartheta_2 - t_W) = \frac{\lambda}{\alpha_G} \frac{F_m}{F_G} : L : \frac{\lambda}{\alpha_W} \frac{F_m}{F_W}$$

Of course these lines can be plotted only if the ratio $F_G{:}F_W$ is given, and as the first path of flow runs approximately in a straight line, one can write $F_m \approx (F_G + F_W)/2$, from which it follows that

$$\frac{F_m}{F_G} \approx \frac{1}{2} + \frac{1}{2} \frac{F_W}{F_G} \quad \text{and} \quad \frac{F_m}{F_W} \approx \frac{1}{2} + \frac{1}{2} \frac{F_G}{F_W}$$

Since, however, $F_G{:}F_W$ is not known, the value of this ratio has to be estimated before one can begin plotting the network of lines. If, after plotting, it is found that either a part of the gas surface or a part of the water surface is not covered by the network, a new value $F_G{:}F_W$ has to be selected, and this procedure will have to be repeated until both surfaces are completely covered by lines of flow.

The plotting of a network of lines is carried out in the following manner: First, the plot shown in Fig. 8 is made. Next, the straight lines corresponding to whole-numbered temperatures are extended to the left. If $F_G{:}F_W = 1$, the meshes of the plot showing the first path of flow are squares (Fig. 9). If, however, F_G is not equal to F_W, the second line of flow has to be curved in such a manner as to give the desired ratio $F_G{:}F_W$, and the temperature lines are next plotted at right angles to both lines of flow.

Fig. 9 shows that the second line of flow is but slightly curved; hence the plotting of the system of lines does not involve any difficulties. After the first path of flow has been plotted, the temperature lines are extenaed as one sees fit. At right angles to them the third line of flow is plotted in such a manner that in the meshes of the network of lines the average length is equal to the average width. Thereupon it is necessary to determine whether Equations [1] and [4] are satisfied. If in the two equations below the values belonging to the first path of flow are denoted by asterisks, then

$$F_G \alpha_G (t_G - \vartheta_1) = F_G{}^* \alpha_G \, (t_G - \vartheta_1{}^*)$$
$$F_W \alpha_W \, (\vartheta_2 - t_W) = F_W{}^* \alpha_W (\vartheta_2{}^* - t_W)$$

Here ϑ_1 and ϑ_2 are the average temperatures of the gas and water surfaces, respectively, of the second path of flow, and may be determined from the chart. From these equations the values of F_G and F_W for that path are determined. If they do not agree with the chart, the third line of flow is shifted correspondingly. When this is done the lines of temperature are plotted at right angles to the new lines of flow, and in doing this it is necessary to make certain whether or not in each mesh of the network the average length is equal to the average width. This is continued until the entire network is plotted.

After the first path of flow has been determined, it is advisable to continue the plotting by means of the equations

$$F_G = F_G{}^* \frac{t_G - \vartheta_1{}^*}{t_G - \vartheta_1} \quad \text{and} \quad F_W = F_W{}^* \frac{\vartheta_2{}^* - t_W}{\vartheta_2 - t_W}$$

two lines which permit reading off the surfaces F_G and F_W belonging to any desired wall temperatures ϑ_1 and ϑ_2. The network as finally obtained is shown in Fig. 10. In the last passage of flow, $f_m < l_m$.

In *Zeitschrift des Vereines deutscher Ingenieure*, vol. 67, 1923, p. 905, Dr. Geiger described another methoa intended to attain the same result. The advantage of the method just described as compared with that of Dr. Geiger's is that it does not depend on the skill of the draftsman making the plot. Furthermore, the present author believes that the Geiger diagram if used for the determination of temperature within the wall would give incorrect data because the assumptions on which it is based do not apply even approximately in the case of comparatively long paths of heat flow. (Dr. K. Lachmann, Berlin, in *Zeitschrift des Vereines deutscher Ingenieure*, vol. 72, no. 32, Aug. 11, 1928, pp. 1127–1128, 6 figs., *p*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

The Conference Table

THIS Department is intended to afford individual members of the Society an opportunity to exchange experience and information with other members. It is to be understood, however, that questions which should properly be referred to a consulting engineer will not be handled in this department.

Inquiries will be welcomed at Society headquarters, where they will be referred to representatives of the various Professional Divisions of the Society for consideration. Replies are solicited from all members having experience with the questions indicated. Replies should be as brief as possible. Among those who have consented to assist in this work are the following:

ARCHIBALD BLACK, *Aeronautic Division*	*J. L. WALSH,* *National Defense Division*
A. L. KIMBALL, JR., *Applied Mechanics Division*	*L. H. MORRISON,* *Oil and Gas Power Division*
H. W. BROOKS, *Fuels Division*	*W. R. ECKERT,* *Petroleum Division*
R. L. DAUGHERTY, *Hydraulic Division*	*F. M. GIBSON and W. M. KEENAN,* *Power Division*
WM. W. MACON, *Iron and Steel Division*	*WINFIELD S. HUSON,* *Printing Industries Division*
JAMES A. HALL, *Machine-Shop Practice Division*	*MARION B. RICHARDSON,* *Railroad Division*
CHARLES W. BEESE, *Management Division*	*JAMES W. COX, JR.,* *Textile Division*
G. E. HAGEMANN, *Materials Handling Division*	*WM. BRAID WHITE,* *Wood Industries Division*

Applied Mechanics

Deflection of Beams

AM-8 According to the formula $D_{max} = 5WL^3/384EI$ given in Carnegie's Handbook, the deflection of a simple beam with uniform load depends on the modulus of elasticity and the moment of inertia. The strength of the steel does not seem to enter into this formula and as a result it appears that two simple beams, one of 50,000 tensile strength and the other of 70,000 tensile strength of the same section and under the same load conditions will deflect exactly the same amount. This does not seem to be exactly right, and any information tending to clear up the matter will prove helpful.

In all deflection formulas for steel beams the strength of the steel enters only in so far as the load-carrying capacity of the beam is concerned. The load-carrying capacity of a beam is directly proportional to the yield point of the steel. The ultimate tensile strength of the steel does not enter, but only the yield point.

The deflection formula quoted for a simple beam uniformly loaded and given in all handbooks does not give the total deflection of a beam. If in this formula the true value for the modulus of elasticity of steel, namely, 30,000,000 lb. per sq. in., is substituted for E, the deflections computed will be too low. This is due to the fact that the deflection formula quoted takes only into account the deflection resulting from the tensile and compressive stresses in the beam, and entirely ignores the deflection resulting from the shearing stresses. If 30,000,000 lb. per sq. in. is substituted for E in the formula, the deflection obtained for a rectangular beam will be from $^1/_2$ to $1^1/_2$ per cent too low, and for I-beams the result will be too low by from 5 to 15 per cent, depending upon the ratio of depth of beam to span length. In practice we usually correct for this inaccuracy by using a somewhat lower value for E than 30,000,000 lb. per sq. in. For instance, for a beam of rectangular section the ratio of B used should be 28–29,000,000 lb. per sq. in. and for an I-beam or plate girder 25–26,000,000 lb. per sq. in. in order to obtain an approximately correct answer.

As far as we know, Young's modulus for all steels is in the neighborhood of 30,000,000 lb. per sq. in., and it varies only over a very narrow range on either side, depending upon the composition of the material. The variation from 30,000,000 lb. per sq. in. is so slight that it is not ordinarily taken into account. More definite information on this point might be obtained from the Bureau of Standards at Washington, D. C.

The two similar simple beams of the same cross-section and similar load distribution but one made out of steel having a tensile strength of 50,000 lb. per sq. in. and the other a tensile strength of 70,000 lb. per sq. in. will have for all practical purposes the same deflection for the same applied load. The only difference in the behavior of these two beams will be that the beam made of higher-strength steel will have a higher ultimate load-carrying capacity. The slight difference in the modulus of elasticity, if any exists between the two steels, is too small to enter into the discussion.

For the additional deflections resulting from shearing stresses in a beam the reader is referred to Morley's "Strength of Materials," pp. 238 to 245, inclusive, or any other corresponding book on that subject. (Albin H. Beyer, Director of Testing, Columbia University, Testing Laboratories, New York, N. Y.)

Materials Handling

Sand-Blast Sand Disposal

MH-3 What are the opinions of readers of Mechanical Engineering regarding the possibility of disposing of sand from sand-blast rooms by blowing it through pipes to a river approximately 100 ft. away? Approximately three cubic yards of sand per hour must be handled. What size of fan or fans is recommended and where should they be located—at the source, point of delivery, or both?

It is believed that a device similar to that used by George F. Geis, assistant electrical engineer of the Berwind-White Coal Mining Co., Windber, Pa., will be the most satisfactory under the circumstances. This equipment may be described as follows:

A pneumatic displacement conveyor is used to elevate and transport the sand used on their haulage locomotive to prevent slipping. The traction sand is received in carload lots and unloaded from the car into the dry room by gravity. On account of the surface equipment of the mine's being located on the side of a hill, it is necessary that the dry room be located about 350 ft. from and about 40 ft. below the sand bin. The pneumatic conveying system has been devised to lift the dry sand to the bin from which the motors receive their supply. The local engineers devised this system many years ago and it has proved highly satisfactory. Similar equipment has been installed in seven mines, but it has been standardized as regards the general form only. The one described below is located in Mine No. 35 and

represents the most severe conditions of all of these installations. The equipment required consists of a Sullivan 6 × 6 or 7 × 6 Class WG-6 compressor, air receiver, displacement tank, and pipe from the displacement tank to the storage bin. The unloader on the compressor is set to load at 75 lb. and unload at 90 lb. pressure. The vertical air receiver is 44 in. in diameter by $7^1/_2$ ft. high. The displacement tank or sand chamber is made from a length of 14-in. cast-iron pipe fitted with flanges and plates at both ends. This is located in a vertical position and the compressed-air line is introduced through the top to a position about one-quarter of the length of the chamber from the bottom. The end of the sand discharge pipe is located but a few inches from the bottom of the sand chamber and passes through the top of the sand chamber for a vertical lift of 21 ft. 6 in. where it is connected by means of a pipe tee to the inclined length of pipe about 350 ft. long which leads to the top of the storage bin at an elevation of 18 ft.

The conveyor consists of 2-in. extra-heavy wrought-iron pipe for the sand pipe, and in this installation the average life of sections near the bin is about three months, and of the sections near the sand chamber is about eighteen months. This great difference in life is accounted for by the fact that the air pressure is decreasing and hence the volume of air is increasing from the chamber to the bin, and therefore the sand is traveling four or five times as fast at the discharge end. Wherever there is a bend in the pipe, the wear is unusually severe. A pipe tee installed at the 90-deg. angle above the sand chamber will last ten times as long as an ell. This is undoubtedly due to the fact that the blind end of the tee becomes filled with sand on each operation, and the excessive abrasion occasioned by turning the direction of the sand through 90 deg. is taken up on the sand itself.

In the head of the displacement tank or sand chamber is located a 4-in. plug. The bulk sand is first thoroughly dried in the sand stove and then the displacement tank is filled through this 4-in. hole by inserting a large funnel equipped with a strainer. The displacement tank is filled by hand with the dried sand. After replacing the plug, the operator opens the valve in the air line and as the only outlet for the air is the sand discharge pipe, it escapes through this pipe and carries sand along with it up to the sand bin. Here the air exhausts at atmospheric pressure and the sand drops into the bin. The volume of the sand chamber is about 7.2 cu. ft. Taking the weight of dry sand at 100 lb. per cu. ft. and considering that it is impossible to blow out all of the sand in the chamber, about 700 lb. is a fair figure to assume for one charge of sand. With the air pressure maintained between 75 and 90 lb., the average time required to blow one complete charge over to the bin is about 8 min. In order to gain some idea of how much air is required per charge, the air in the receiver was brought up to pressure and the compressor disconnected. A normal charge of the displacement tank was then conveyed to the storage bin. The initial pressure was 84 lb. and when the last of the charge was blown over, at the end of 18 min., the pressure was about 43 lb. The volume of the air receiver and pipe is about 80 cu. ft. This amount of air at 43 lb. is about equivalent to 48 cu. ft. at 84 lb., so we might say an equivalent of about 32 cu. ft. at 84 lb. was used. The average pressure during this test, however, was much lower than normal, and since the efficiency was also much lower than normal, as shown by the more than doubled time required, we believe a fair estimate to be 25 to 30 cu. ft. of air per charge at normal pressure or about 175 to 210 cu. ft. of free air.

The average duty is about 15 charges per day or about 375 per month or about 260,000 lb. of sand per month.

Such a device must be loaded by gravity or manually. It has the great advantage of simplicity and of requiring a minimum amount of new equipment.

The problem could be solved by straight pneumatic conveying equipment which utilizes a rotary vacuum pump. As the conveying air is mixed intimately with the sand with such equipment, it is necessary to introduce a filter near the discharge end of the system. This offers a slight complication and increased initial investment.

Should your inquirer be interested in equipment of this nature, we should suggest getting in touch with the Dust Recovering & Conveying Co., Cleveland, Ohio.

Reverting to the displacement-type conveyor which utilizes compressed air, we wish to call attention to the fact that a higher efficiency could be expected from the use of a slightly different design of charging machine. We are attaching hereto a copy of our data sheet 10.025.14 (46) which gives a detail of the powder-loading gun developed by the United Verde Copper Co., Jerome, Arizona. This is a satisfactory means of providing an intimate mixture of air and sand in proper proportions, and will reduce the quantity of air required. Any pneumatic conveying system for conveying an abrasive material such as sand introduces a serious wear on the conveying pipe which cannot be avoided. Some idea of the rate of this wear is given above. It has been the writer's opinion for some time that this wear could be overcome in a large measure by lining the conveying pipe with a layer of rubber by using the special rubber composition manufactured by the Phoenix Machine Co., 1339 Flatbush Ave., Brooklyn, N. Y. This rubber preparation becomes liquid when heated. It could be applied to the inside of relatively small-diameter pipes by capping one end, standing them vertically, and pouring the composition into the cylinder thus formed. A reasonable amount of experimenting would determine how long this would have to stand to deposit a sufficiently thick coat of the composition on the inside of the pipe. This composition is used, as you undoubtedly know, in the sand-blast process of cutting lettering in stone, and offers great resistance to the abrasive action of sand. Butt-jointed pipe would have to be used to prevent as much as possible the ends of the coating working loose. (S. H. Downs, Chief Engineer, Clarage Fan Co., Kalamazoo, Mich.)

Management

Repair Costs in Machine Shops

MG-2 What is a reasonable figure for yearly repair costs of milling machines, planers, lathes, etc., as a percentage of the original cost of the machines?

A reasonable figure for the yearly repair costs is 3.5 per cent of their replacement price. This figure has been obtained from a study of the repair cost of a number of plants over a period of years with equipment kept in first-class condition at all times. It does not represent specifically the machines listed, as it includes many others, and is the average of all of the equipment used, such equipment operating at an average of 66.6 per cent of the total operating time of the plant. (W. L. Churchill Industrial Economist, White Plains, N. Y.)

Questions to Which Answers Are Solicited

Machinery Control

M-1 Why is not more use being made in mechanical engineering of control of machinery by perforated strips?

Uses for Waste Gypsum

M-2 For what purposes is waste gypsum collected from the tables in plate-glass manufacturing plants used?

Correspondence

The First Steam Hammer

To the Editor:

The publication in the June number of Mechanical Engineering of Mr. Field's article "Mechanical Invention as a Form of Expression," containing the reproduction of a page from James Nasmyth's "Scheme Book" showing his sketch for a steam-driven hammer, and the ascription to him anew of the invention of the steam hammer, impel me again to attempt to give credit where credit belongs and to correct some errors which appear in Nasmyth's autobiography.

In it Nasmyth states that his partner, Mr. Gaskill, one day showed to M. Schneider, owner of the Creusot Works in France, and to his able engineer, M. Bourdon, this "Scheme Book," and especially this drawing, and that M. Bourdon took careful notes and sketches of its constructive details. There is grave reason for doubting the accuracy of this statement both because of contradictions in Nasmyth's further account and for other reasons which I shall shortly give.

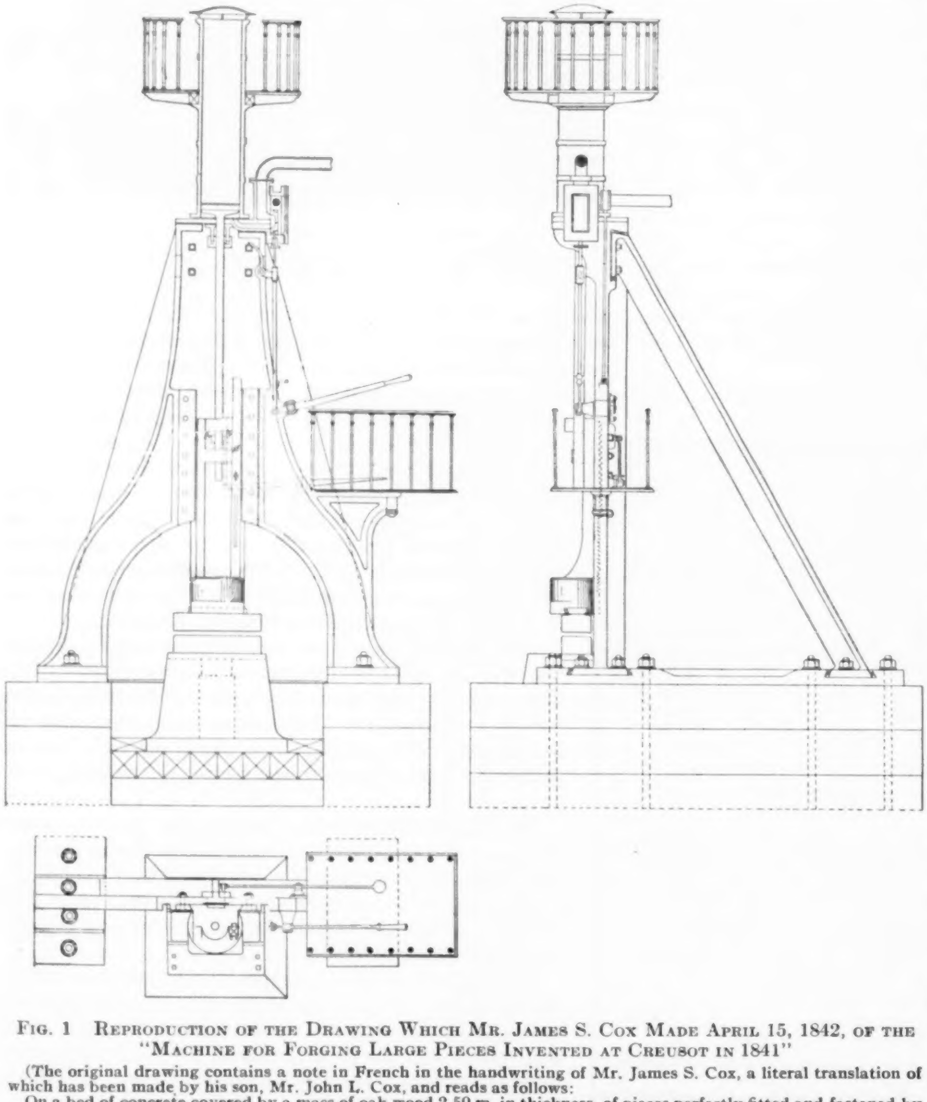


Fig. 1 Reproduction of the Drawing Which Mr. James S. Cox Made April 15, 1842, of the "Machine for Forging Large Pieces Invented at Creusot in 1841"

(The original drawing contains a note in French in the handwriting of Mr. James S. Cox, a literal translation of which has been made by his son, Mr. John L. Cox, and reads as follows:

On a bed of concrete covered by a mass of oak wood 2.50 m. in thickness, of pieces perfectly fitted and fastened by large iron nails, is set a block or mass of cast iron of about 10,000 k. It has at the upper part a dovetail of 5 c/m, about, by 40 c/m wide, to hold the anvils, stamps and the various molds in which one should fashion the forgings. They are held in this dovetail by 2 keys driven by blows of a hammer. The middle of this dovetail is pierced by a round hole of 0.35 in diameter which communicates with a cavity in the interior to allow passage of the punchings of the pieces which are to be pierced hot. These punchings are withdrawn by a side opening.

On each side of this block are erected, up to the level of the ground, two walls of cut stone on which are fastened the 2 foundation plates serving as base for a frame of cast iron and for its 2 struts. On top of the frame is bolted a steam cylinder of 0.46 in diam. and 2.25 in height. Its bottom, traversed by the piston rod, is cast in one piece with the steam chest.

The slide valve is operated by a lever. A throttle valve to regulate the amount of steam; a pedal which operates a dog which holds the ram suspended at a desired height by means of a rack fastened to its rod. Steam produced by the waste heat of the furnace for heating the piles. Effective pressure 2 atm. The piston, forged in a single piece with its rod, has metallic packing pressed outwardly by springs. The weight of this packing should be reduced as much as possible.

Weight of the ram with piston, 3000 k. Head room over the anvil, 2 meters. Accessories; 2 cranes, 1 winch; 2 heating furnaces; 1 large forge fire; 1 capstan driven by the blowing engine or any other to handle on rollers the large porter bars.)

He goes on to say that in April, 1842, he visited Le Creusot, finding M. Schneider absent, but M. Bourdon at home. "M. Bourdon received me with much cordiality. As he spoke English with fluency, I was fortunate in finding him present in order to show me over the works; entering which, one of the things that particularly struck me was the excellence of a large wrought-iron marine engine single crank, forged with a remarkable degree of exactness in its general form . . . I inquired of M. Bourdon 'how that crank had been forged.' His immediate reply was, '*It was forged by your steam hammer.*' "

"Great was my surprise and pleasure at hearing this statement. I asked him how he had come to be acquainted with the steam hammer. He then narrated the circumstance of his visit to the Bridgewater Foundry during my absence. He told me of my partner having exhibited to him the original design, and how much he was struck by its simplicity and probable efficiency; that he had taken careful notes and sketches on the spot; that among the first things he did after his return to Creusot was to put in hand the necessary work for the erection of the steam hammer; and that the results had in all respects realized the high expectations he had formed of it."

"M. Bourdon conducted me to the forge department of the works, that I might, as he said, 'see my own child;' and there it was, in truth—a thumping child of my brain! . . . On inspecting the steam hammer, I found that M. Bourdon had omitted some important details, which had led to few mishaps, especially with respect to the frequent breaking of the piston rod at its junction

with the hammer block . . . I sketched for him, then and there, in full size, on a board, the elastic packing under the end of the piston rod, which acted, as I told him, like the cartilage between the bones of the vertebrae, preventing the destructive effects of violent jars. I also communicated to him a few other important details, which he had missed in his hasty inspection of my design. He expressed his obligation to me in the warmest terms, and the alterations which he shortly afterward effected in the steam hammer, in accordance with my plans, enabled it to accomplish everything that he could desire."

In this account the statement is first made that Bourdon took careful notes and sketches of the constructive details of Nasmyth's drawing, then that Bourdon admitted making such careful notes and sketches, and lastly that Bourdon's inspection of the drawing had been so hasty that he missed important details of the design. This discrepancy of statement is very noticeable, but a far greater doubt will be thrown on the accuracy of Nasmyth's account if one will compare his design with that of the hammer actually constructed by Bourdon, which I show here (Fig. 1) together with the design from which it is claimed he copied it (Fig. 2). M. Bourdon was an engineer of great ability and it is inconceivable that any one who had seen the comparative perfection of Nasmyth's modern-looking hammer could have designed so crude a tool as that built by Bourdon. It shows every evidence of being a first attempt. The drawing is taken from a tracing made by my father, the late Mr. James S. Cox of Philadelphia, at Le Creusot, April 15, 1842.

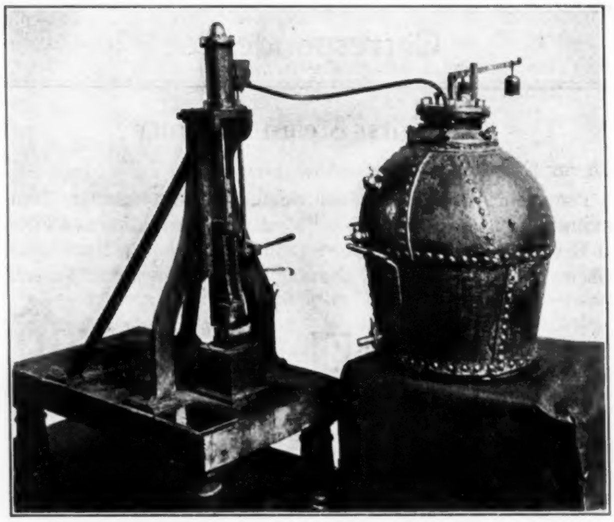


FIG. 3 MINIATURE STEAM HAMMER USED IN THE STUDIES OF MM. SCHNEIDER & CIE BEFORE THE CONSTRUCTION OF THE FIRST INDUSTRIAL STEAM HAMMER, LE CREUSOT, 1838.

Very grave doubt is further thrown on the accuracy of Nasmyth's account by the following story which was several times told me by my father. In August, 1841, Mr. Cox graduated as an engineer from the École Centrale des Arts et Manufactures at Paris and spent considerable time inspecting various industrial establishments in Europe. At the Creusot works he had become acquainted with M. Bourdon, who took a great fancy to him and invited him to pay a visit, which he did in April, 1842. M. Bourdon then took him into a secret inclosure in the works where the first steam hammer was running. Much impressed, Mr. Cox asked and received permission to copy the drawings of this tool. The cut I enclose is made from a print of this tracing (Fig. 1). The place and date of the invention are given on it as Creusot, 1841.

One day, later, a hurried message was received by Mr. Cox from M. Bourdon, asking him to come at once to the works and interpret, as Bourdon, who spoke little English, had an English visitor. Mr. Cox promptly responded and accompanied the gentlemen into the works where he explained to James Nasmyth, the visitor, the working of the new tool.

Had Nasmyth's account been correct, Bourdon would have needed no interpreter as, according to Nasmyth, Bourdon spoke English fluently. Further, Mr. Cox had no recollections of any sketches being made by Nasmyth for Bourdon, as described by the former, nor of any explanations being made by him.

That night at dinner M. Schneider, who had been absent during the day, when told by M. Bourdon that Mr. Nasmyth of England had been at the works, started up saying, "You didn't show him the steam hammer, did you?" When M. Bourdon replied, "Yes," M. Schneider struck the table a blow with his fist, exclaiming, "He'll patent it in England tonight." Mr. Nasmyth returned to England and immediately took out a patent on the steam hammer.

That Mr. Nasmyth was not entitled to the credit for the invention was later confirmed to Mr. Cox when, after taking out the patent, Mr. Nasmyth offered the American agency for the patent to this young man whom he had met but once, of whom he knew nothing, who was only just out of college, who was but twenty years old, who had no business experience, no business connection with the United States, and had not been in America since he was seven years old:

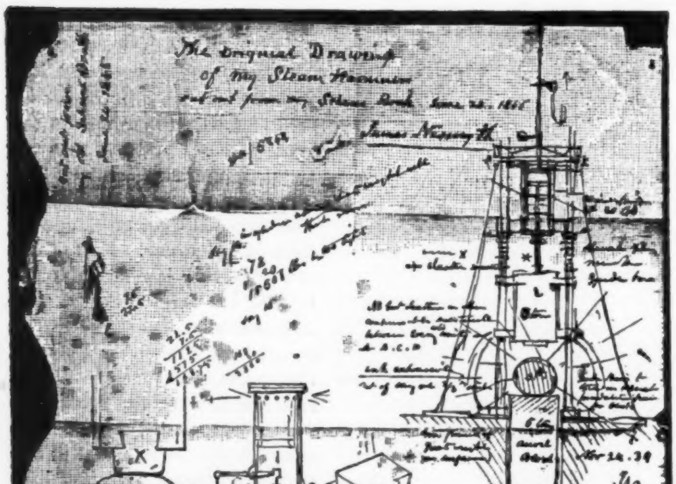


FIG. 2 NASMYTH'S SKETCH OF HIS STEAM HAMMER TAKEN FROM HIS "SCHEME BOOK," DATED NOVEMBER 24, 1839, AND REPRODUCED FROM HIS AUTOBIOGRAPHY

a truly flattering offer which was declined because of its being unethical.

From MM. Schneider & Cie I have just received the accompanying photograph of the model hammer constructed before building the commercial tool. The corner tablet bears an inscription, not legible in this photograph, which translated, reads:

MINIATURE STEAM HAMMER
used in the studies of MM. Schneider & Cie
before the construction of the
FIRST INDUSTRIAL STEAM HAMMER
Le Creusot 1838

Nasmyth may have made his sketch in 1839, but I think there can be no doubt that the Frenchmen had not seen it before starting the Creusot hammer, if ever, and that to Francois Bourdon is due the distinction of having invented, and to MM. Schneider & Cie the credit for having constructed the first steam hammer.

JOHN L. COX.[1]

Philadelphia, Pa.

Revisions and Addenda to Boiler Construction Code

IT IS THE policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revision of the Rules and its Codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the Code, to be included later on in the proper place in the Code.

During the past two years the Boiler Code Committee has received and acted upon a number of suggested revisions which have been approved for publication as addenda to the Code. These are published below, with the corresponding paragraph numbers to identify their locations in the various sections of the Code, and are submitted for criticisms and comment thereon from any one interested therein. Discussions should be mailed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the Committee for consideration.

After 30 days have elapsed following this publication, which will afford full opportunity for such criticism and comment upon the revisions as approved by the Committee, it is the intention of the Committee to present the modified rules as finally agreed upon to the Council of the Society for approval as an addition to the Boiler Construction Code. Upon approval by the Council, the revisions will be published in the form of addenda data sheets, distinctly colored pink, and offered for general distribution to those interested, and included in the mailings to subscribers to the Boiler Code interpretation data sheets.

For the convenience of the reader in studying the revisions, all added matter appears in small capitals and all deleted matter in smaller type.

Par. P-195. Revise sixth section printed in July issue of MECHANICAL ENGINEERING to read: A BLANK HEAD OF A SEMI-ELLIPTICAL FORM IN WHICH THE MINOR AXIS OF THE ELLIPSE IS AT LEAST ONE-HALF THE DIAMETER OF THE SHELL SHALL BE MADE AT LEAST AS THICK AS THE REQUIRED THICKNESS OF A SEAMLESS SHELL OF THE SAME DIAMETER. IF A MANHOLE IS PLACED IN AN ELLIPTICAL HEAD THE THICKNESS SHALL BE THE SAME AS FOR AN ORDINARY DISHED HEAD WITH A RADIUS EQUAL TO 0.8 THE DIAMETER OF THE SHELL AND WITH THE ADDED THICKNESS FOR THE MANHOLE.

Par. P-230*b*. Revise first section printed in July issue of MECHANICAL ENGINEERING to read: *b* In a form of CONSTRUCTION [reinforcement] for crown sheets where the top sheet of the firebox is a part of a circle OF A RADIUS EXCEEDING 55 PER CENT OF THE WIDTH OF THE FIREBOX, THAT PART OF THE CROWN SHEET, not exceeding 120 deg. in arc, MAY BE [and is] braced with arch bars extending over the top and down below the top row of staybolts [at the sides] CONNECTING THE FIREBOX SHEET AND WRAPPER SHEET WHERE THESE SHEETS BECOME PARALLEL, these arch bars being riveted to the water side of the crown sheet through thimbles, and the maximum allowable working pressure should be determined by adding to the maximum allowable working pressure for a plain circular furnace of the same thickness, diameter, and length determined by the formula in Pars. P-239 and P-240, the pressure P_1 determined from the following formula, which is a modification of that in Par. P-241*a*: IF THE TOP OF THE FURNACE IS SEMI-CIRCULAR, IN WHICH CASE THE RADIUS IS EQUAL TO 50 PER CENT OF THE WIDTH OF THE FIREBOX, THE ARCH BAR NEED NOT EXTEND DOWN INTO THE WATERLEG BEYOND THE THREE ROWS OF STAYBOLTS AT EACH END.

[1] Asst. to President, The Midvale Company. Mem. A.S.M.E.

The Manufacture of Dry Ice

IN THE making of dry ice an ammonia or CO_2 process is used for cooling, proof in itself of the greater economy of the ordinary process over dry ice, which is not used, though plentiful at the plant. The gas is obtained from an alcohol-making plant, or a lime kiln, if possible, or by burning coke. In the coke oven a ton of fuel makes 3.5 tons of CO_2 gas. The gas also contains sulphur which must be scrubbed out, and the first step is to clean the gas by passing it through trickling water. This also cools the gas. The gas is then absorbed in a solution to get rid of the quantities of nitrogen always present in flue gas, this being passed off as a gas.

In the solution the CO_2 is lightly bound and readily driven off by means of heat, then drawn to the compressor, condensed, and cooled in the liquid state. The liquid expands through a nozzle at atmospheric pressure and turns directly into a solid. About a third of the product by weight can be removed thus, while the remaining part stays as a low-pressure gas to be passed back again through the cycle. It is decidedly advantageous to cool the liquid on the way from the condenser to the orifice by means of refrigeration. The part which is unsolidified passes around until it eventually, bit by bit, becomes solid.

One plant mentioned is near an industrial-alcohol factory and gets 150 tons of gas daily. This helps lower the cost, if the gas can be had steadily. A twelve-ton dry-ice plant is a big one, however small it may seem in comparison with an ordinary ice plant. Considered on the basis of value of product the income is considerable. The load factor on a plant runs about like that of a an ice plant—about 50 per cent.

The author questioned whether the price of dry ice could be brought down much below $75 a ton for some time in the future.

In the discussion which followed it was stated that the price of liquid CO_2 will not come down, as a $15 drum is needed to carry three dollars worth of it.

Another speaker asked about tests made by the Bureau of Foods and Markets showing that carbon dioxide did not work well with fruits. Another speaker stated that this was true of some fruits but not of others, and that from British Food Board data it would appear that a concentration of 10 per cent carbon dioxide had been found to be the most undesirable in stopping respiration and causing spoilage.—From an address by John E. Starr, New York Section of the American Society of Refrigerating Engineers, May 23, 1928, in *Refrigerating Engineering*, vol. 16, no. 2, August, 1928, pp. 45-46.

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers, and Proceedings of

The American Society of Mechanical Engineers

29 West 39th Street, New York

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Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

By-Law: The Society shall not be responsible for statements or opinions advanced in papers or.... printed in its publications (B2, Par. 3).

A Great National Fuels Forum

THE Second National Fuels Meeting in Cleveland, which was a thorough success, also marked a noteworthy advance in achieving the purpose of the originators to provide a general forum for all engineers interested in the economic use of fuel in all industries in all sections of the country. This year's program brought out the railroad and marine men, and other groups have pledged support for coming meetings. One thing that was most encouraging was the conference of representatives of related organizations which ratified the idea of the Fuels Meeting as a great national clearing house for information about fuel use and conservation. Thus the new idea of a separate meeting for each group of specialists in the Society has been justified not only as an improvement in the functioning of the society, but as a rallying point for the industrialists and engineers outside of the Society on questions of broad importance.

Mechanical Week in New York

TWO important changes in the general scheme of the coming Annual Meeting of the A.S.M.E. should be emphasized. The first is the business meeting, to be held on Monday evening, December 3. Formerly this session has been held on Wednesday afternoon, and has necessarily been cut short because of the crowded program. The Council of the Society earnestly desires that the membership shall have ample opportunity for full and free discussion of the policies of the Society, and the change has been made to give an unlimited period for this discussion. The second change is the starting of the technical sessions Monday noon and continuing them through Friday morning. This change comes as a result of the desire of the Committee on Meetings and Program to reduce the number of simultaneous sessions, extending the period of the meeting instead.

Through the splendid cooperation of the authors and Professional Divisions it is possible to give synopses of the papers in this issue of Mechanical Engineering. Members may obtain copies of these papers in advance upon request, and thus be enabled to participate in the discussion to greater advantage.

The coming meeting promises to be the most successful one ever held. The program is an excellent one, an interesting list of entertainments is to be provided, and the attendance will undoubtedly be the largest in the Society's history.

As usual, the National Exposition of Power and Mechanical Engineering will be held in the Grand Central Palace during the week of the meeting, and members attending it will enjoy its splendidly complete showing of all types of machinery of interest to mechanical engineers.

Fewer Dollars per Ton-Mile

AS PRESIDENT BUDD of the Great Northern pointed out at the Summer Meeting of the A.S.M.E., the railroads of the country have entered a new period of development in which the major effort is focused on the perfecting of operation and the use of large and improved mechanical devices. The mechanical engineers on the railroads and in the railway-supply industry must therefore be on the lookout for the newest machines and the latest ideas, and must be prepared to adapt them to the tremendously important problem of delivering a ton-mile at the lowest cost. The Railroad Division of the Society is anxious to assist in satisfying this need, and the railroad sessions at the coming Annual Meeting have been arranged to permit the engineers in the railway-transportation industry to enjoy them and at the same time participate in other sessions where they may obtain valuable information that may be applied to the railroad problem. The perfecting era brings to the mechanical man the opportunity he craves. He joys in making one dollar do the work of two.

President Budd's address, which appears in this issue, outlines the important contribution that the mechanical engineer has already made in this work, and points the way for future activity. It is a stimulating document for the railway mechanical engineer.

Friedrichshafen to Lakehurst

IT WAS a magnificent performance to cross from Germany to the United States in a lighter-than-air craft. The fact that it was done with a new fuel and carrying a considerable number of passengers added still more to its impressiveness. The *Graf Zeppelin* proved once more that dirigibles are capable of covering enormous distances. The question that now arises is whether or not this performance, splendid though it is as a sporting feat and an engineering achievement, inaugurates a new era of transportation. As to this considerable doubt is permissible.

While detailed information is not available, all indications are that the ship operated only with a very slim margin of safety. It did not strike anything like what may be considered as rough winds over the Atlantic, and yet it was delayed for more than thirty hours, had to go far out of its way to seek calmer weather, and in spite of this had one of its stabilizers ripped open. What would have happened had it struck a real Atlantic storm it is difficult to say. From the point of view of speed the performance was not at all impressive, as the time made was less than twenty-four hours shorter than would be required for a crossing on one of the Atlantic greyhounds.

The most disturbing element in this situation is that the *Graf Zeppelin* clearly represents the last word in today's art of lighter-than-air construction, being built as it was by mechanics trained in old Count Zeppelin's works, and in the hands of Eckener, recog-

nized as the best master of lighter-than-air navigation in Europe. What has been done on this passage is therefore approximately the best that can be done, and it will soon be apparent whether this best is good enough to warrant travelers' taking the additional risk and paying for the additional cost of flying by air under somewhat Spartan conditions of comfort rather than wasting two extra days through resorting to conventional methods.

One cannot help comparing the Zeppelin flight with the achievements of Colonel Lindbergh, Chamberlin, and Commander Byrd. In all of these cases the time occupied was barely one-third of that taken by the Zeppelin. The factor of safety was very much lower in the heavier-than-air craft, but the margin of improvement in these appears to be enormous, while apparently quite limited for the lighter-than-air machines. Nevertheless, it cannot be emphasized too strongly that the possibilities of these latter are as yet unknown, and they are sufficiently great to make further research well worth while.

"Manless" and "One-Man" Plants

THE present tendency to cut down the amount of labor employed in power generation and conversion has produced some spectacular results which are only partly understood by the general public. There are already a number of so-called automatic hydroelectric plants. Likewise there are numerous converter plants with outputs running into scores of thousands of kilowatts and no one on the floor; and recently central stations have been operated by a minimum of man power.

These plants do not all belong to the same class by any means, in fact a very clear distinction must be made between two of the classes. To the first belong those plants which, while called "manless" and "one-man," are really nothing of the kind, because they are not manless at all, but are simply controlled from a distance.

As regards, for example, a converter plant, it can be and is controlled from a switchboard many miles away with the same ease and safety as would be the case if the control switch were within the plant walls. By means of distant-reading instruments the operator has the most complete information of all that is going on in the plant, and has every function of its operation under control. The control man must be there in effect, however, and is, though bodily he may be miles away. From this point of view such plants as the Avon Park Station of the Florida Public Service Co., described elsewhere in this issue, represent an entirely different type. There the interesting problem was solved of making the unit—and not a small one—so simple that one man could actually handle the entire control. To do this it was necessary in the first place to make the entire apparatus so thoroughly reliable as to eliminate all necessity for tinkering. The old-style engineer who was always tightening leaky joints and oiling up things would feel out of place in a plant where apparently no leaky joints are permitted and lubrication takes care of itself. All of the equipment possible is located at one floor elevation, and if any of it had to be put into the basement, this was done in such a way that it could be observed from the operating floor. There are no dividing walls between the boiler room and turbine room, or between the turbine room and switch bay, so that a single operator can see almost everything in the plant in walking around the turbine.

An engineer who analyzed production in a textile mill said that an operator there is earning money for the company only when he is doing nothing. This means that he is earning money only as long as the machinery runs without the interference of the operator. The moment the operator starts tinkering with the machine, profits stop. It might be said that the one man who operates the Avon Park Station of the Florida Public Service Co. is likewise earning money for his company only so long as he can walk around his turbine with both hands in his pockets. But think of the high stage that mechanical engineering has reached when it becomes possible to let a 15,000-kw. steam-turbine generating plant practically run itself.

"Blue" Gas

THE recent development in airship propulsion involving the use of oil gas as fuel has led to a revival of interest in this substance as well as to much misunderstanding, beginning with the very name of the gas. As a matter of fact, it is not "blue" gas at all but "blau" gas, so-called because it was developed by a German chemist by the name of Blau. The misunderstanding arose because "blau" in German means "blue."

Accounts appearing in the daily press have given the impression that blau gas is something quite new, which is by no means the case, as the development of this type of gas dates back to the work of Taylor in 1815, and as a matter of fact, as early as 1823 there were eleven English municipal plants which used gas of this type.

Quite a number of oils may be used for the manufacture of this kind of gas, for example, mineral-oil distillates, distillates from lignite tar or shale tar, and in tropical countries even vegetable oils, such as castor oil, have been employed. If mineral oil is used, only the fraction between 250 and 360 deg. cent. gives blau gas. This fraction in oil not subject to cracking lies between kerosenes and the lubricating oils, and constitutes something like 10 per cent of the crude.

The gas is obtained by spraying gas oil into highly heated retorts. This produces first a vaporization of the oil and then a break-up resulting in the transformation of the oil into oil gas, tar, and coke, together with a certain amount of soot and lampblack. The proportions of the constituents of the derived products can be regulated to a considerable extent by proper control of temperature and composition of initial material. The gas consists of light hydrocarbons, such as propanes, pentanes, etc., and may be used in various ways. The Blau Gas Company, of Augsburg, Germany, produce a liquid oil gas which they call "blau gas" by gasifying the oil at temperatures of from 500 to 600 deg. cent. This gas is next purified and compressed to a pressure of 20 atmos. in reciprocating pumps cooled by the injection of a water spray. In this way hydrocarbons of the benzene type are segregated, while the residuary gaseous materials are compressed to 100 atmos. Under this latter pressure the gas is liquefied or loses a part of its very low-boiling gaseous compounds. It is stated that 100 lb. of gas oil will produce from 30 to 40 lb. of blau gas, 5 to 6 lb. of benzene, 50 to 55 lb. of tar, and 5 to 6 lb. of non-condensible gases. Blau gas looks like water, has a specific gravity of 0.51, and boils at —60 deg. cent. When used it is vaporized in a boiler at 6 atmos. pressure and employed in the form of the resulting vapor. Its heat content is 14,800 large calories per kilogram (26,640 B.t.u. per lb.). In air mixtures it explodes within the limits of 4 per cent gas to 96 per cent air up to 8 per cent gas to 92 per cent air, or substantially those under which gasoline-air mixtures become explosive.

Apparently the main advantage in the carrying of blau gas on airships is the fact that it simplifies the matter of compensating for loss of weight, which is a serious matter when gasoline is used, and possibly makes the handling of an airplane easier. On the other hand, it must be very much more expensive than gasoline, and probably is not as efficient.[1]

[1] Those interested further in the subject are referred to an article by Hallock in the *Journal of the Chemical Industry*, 1908, p. 550, and for gas oil generally to Prof. Fritz Ullmann's Enzyklopadie der technischen Chemie, vol. 8, pp. 575, et seq.

The New England Industries Meeting

Successful Meeting in Boston Featured by Discussions of Technical Problems of New England Industries, Excursions to Industrial Plants, and Visits to Points of Historical Interest

BOSTON extended a most cordial welcome to The American Society of Mechanical Engineers on the occasion of the New England Industries Meeting, October 1 to 3, 1928, which was attended by over five hundred members and guests. The Council of the Society held a meeting on Monday morning, with Vice-President Charles L. Newcomb in the chair. Routine business was transacted. An excellent program of entertainment events, ten technical sessions, and excursions to the interesting plants in and around Boston filled the three days of the meeting for the men. In the meantime the ladies were well entertained by visits to the many points of historical interest in Boston and vicinity.

The most interesting feature of the meeting was the dinner Tuesday evening, October 2, in the ball room of the Hotel Statler. Charles C. Pierce, of Boston, presided as toastmaster, and his excellent spirit made the evening a success. Dr. Ira N. Hollis, Past-President of the Society, extended a welcome on behalf of the Boston engineers. He pointed out that each meeting of the Society was a monument of friendship, and Charles L. Newcomb, Vice-President, responded in a like vein. Lieut. S. L. Willis, of the Aeronautic Branch of the Department of Commerce, represented the Hon. W. P. MacCracken, Jr., who was expected to speak on "The Development of Commercial Aviation." Lieutenant Willis presented an exceedingly interesting outline of the activities of the Department of Commerce in regulating 140 airplane factories, supervising 13,000 miles of airways, overseeing the licensing of pilots, and inspecting airplanes. An important phase of the work of the Department of Commerce is in that of analyzing accidents, only four per cent of which occur on regularly scheduled runs under careful Government supervision. Half of these are fatal. Seventeen per cent of the total accidents that occur in the training schools are fatal.

The final feature of the evening was a fascinating talk by Dr. Harrison E. Howe on "The Place of Science in the New Competition." Dr. Howe used a large black bag as his notebook, from which he drew interesting exhibits of the contributions of chemistry to the advancement of improved operation of industry and the utilization of so-called industrial wastes. After his talk the floor was cleared, and the gathering enjoyed dancing until a late hour.

The technical sessions were notable for the volume and excellence of the discussion which they elicited. The topics dealt with in the papers presented were selected with the idea of giving the members in New England an opportunity to discuss their many technical problems.

Materials-Handling Session

Compton D. Bray, of New York, presided at this session, at which Daniel W. Coe showed motion pictures dealing with the "Handling of Marine Shipments of Pulpwood." C. G. Spencer, of New York, outlined the principles of "Handling Material in Sugar Refinery Operations." The final event was the showing of motion pictures of handling operations in a Ford assembly plant, one of which was visited at Somerville, Mass., during the meeting.

Education and Training for the Industries

This session on Monday afternoon, October 1, was taken up with a discussion of apprenticeship problems. Charles K. Tripp, of Lynn, Mass., described the methods of training apprentices at the Lynn plant of the General Electric Company, and Walter S. Berry revealed the experiences of the Scovill Manufacturing Company in the use of tests for selecting apprentices. The discussions stressed the need for well-developed technique of training apprentices and the importance of well-trained teachers. Howard Coonley, of Boston, presided.

Management Session

William J. Fortune, of Boston, wrote the opening paper at this session on Tuesday morning, October 2, which was presented by A. E. Larson. His paper outlined the opportunity for the engineer to improve merchandising and distribution methods in infant industries. The discussion emphasized the fact that New England was having a very prosperous period, and pointed out the importance of not only developing new methods of merchandising but of developing better manufacturing methods, and adopting modern machinery.

The second paper, by Jerome R. George, on the "General Management of Industry," outlined some fundamental duties of the qualified industrial manager. In the discussion it was pointed out that self-satisfaction has no place in management.

Applied Mechanics Session

Prof. E. Norton of Harvard University, presided at two sessions on applied mechanics with crowded discussion, one held on Tuesday morning, October 2, and the other on Wednesday morning, October 3. A paper by Prof. A. Dinnik, of Russia, on "The Design of Columns of Varying Cross-Section," was presented by Prof. M. D. Sayre, of Union College, Schenectady. The second paper, on "The Mechanics of Plate Rotors for Turbo-Generators," was presented by J. P. DenHartog, of East Pittsburgh.

At the second applied mechanics session, Major J. B. Rose, of Watertown Arsenal, presented D. A. Gurney's paper giving results of "Tests on Belleville Springs by the Ordnance Department." The second paper, by A. B. Kinzel, of Long Island City, described a "Method of Evaluating the Technical Worth of a Steel from Physical Test Data."

Session on Aeronautics

In opening the aeronautic session on Tuesday morning, October 2, President S. W. Stratton, of Massachusetts Institute of Technology, emphasized the substantial character of the development of commercial aviation in the United States. A paper on "Air Transportation in Relation to New England," prepared by Sumner Sewall, was presented by B. A. Pollet. It dealt with the possible use of the amphibian plane for New England conditions. The discussion centered about the possible uses of amphibian planes in inland cities and the flying characteristics of such planes. A. Willgoos, of Hartford, described the "Modern Aviation Engine," and emphasized the need for care and inspection of parts for airplane engines. The final paper reviewed the principles underlying the application of anti-friction bearings to aircraft, and was presented by F. W. Mesinger, of New York.

Railroad Session

The railroad session on Tuesday morning, October 2, dealt with mechanical car retarders, electric interlocking systems, and

train stops. L. Richardson, of Boston, outlined the development of car retarders and described the details of operation. Motion pictures of the car retarders were shown. R. J. Cullen, of Boston, spoke on interlocking systems, describing the installation of the Boston & Albany R.R. at Springfield, Mass. Train stops and automatic train control were dealt with by H. S. Walton, of West Springfield, Mass. The discussion centered about the requirements of the Interstate Commerce Commission that the railroads instal train-stop devices, and the costs of such installations. The rapidity of present developments was emphasized as presaging modification to train-stop equipment in the near future.

Following the session those present visited the hump yard of the Boston & Maine Railroad to view the mechanical retarders in use.

Power Session

The single paper by Frank M. Gunby, of Boston, on "Power Supply for New England Industry," drew out discussion that lasted over three hours at the power session on Wednesday morning, October 3, which was presided over by Fred M. Gibson, of Brooklyn. Mr. Gunby showed the rates of increase of uses of power in New England, analyzed the sources of supply, and compared costs of power in various sections of the country. The discussions centered on the factors which influenced the apparent high cost of power to New England industries, and brought out the relationship of these factors with diversity of operation of various industries in the district.

Machine Shop Practice Session

Alden M. Drake, of Greenfield, Mass., opened the machine-shop practice session with a paper on "Internal-Grinding Development," in which he described the various devices of internal grinders and their underlying principles. The discussion was focused on the difficulties of cooling work, and covered the importance of hydraulic operation and the use of anti-friction bearings at high speeds.

A paper describing "Methods and Processes in a Textile Machinery Plant," and presented by J. F. McEnneny, of Auburn, R. I., pointed out the need for accuracy of interchangeability in the large number of small parts used in textile machinery. The need for education in mass-production methods, the importance of adequate standards, and the accuracy of requirements were treated from many different angles. Prof. E. F. Miller, of Massachusetts Institute of Technology, acted as chairman of the session.

Wood-Industries Session

At the Wood-Industries Session on Wednesday morning, October 3, Arthur D. Little, of Cambridge, Mass., occupied the chair. President S. W. Stratton, of Massachusetts Institute of Technology, opened the session with interesting discussion on the "Educational Requirements of the Application of Engineering to the Wood Industries." He presented an analysis of the engineering questions that were involved in the successful development of wood industries, and outlined the relations of these questions to various agencies that are engaged in education and research in them. Chairman Little dealt with the question of wood substitutes and new preservative coatings for wood. He presented a large amount of new information on these subjects.

A paper on "Mechanical Handling of Lumber," prepared by Carle M. Bigelow and Thomas D. Perry, of Boston, was presented by Mr. Perry.

Technical Committee's Meetings

The Special Research Committee on Strength of Gear Teeth, Wilfred Lewis, Chairman, held a meeting on Tuesday afternoon, October 2, in the laboratory of Prof. Earle Buckingham, at the Massachusetts Institute of Technology, where the Committee's gear-testing machine is set up. Alterations have recently been made to this machine in order that tests may be run to check the accuracy of the conclusions developed in the progress reports of the Committee that have appeared recently in MECHANICAL ENGINEERING. Professor Buckingham demonstrated to the several members of the Committee present how the machine is to be used in this work, and the proposed program was discussed.

The Special Research Committee on Saws and Knives, Carle M. Bigelow, Chairman, presented its first Progress Report at the wood-industries session on Wednesday morning, October 3, Thomas D. Perry representing Carle M. Bigelow, Chairman of the Committee. Considerable interest was shown in the Committee's plans through the discussion of the report at this time. Following the session those particularly interested in the subject met informally to discuss the proposed program. The industries interested in the use and manufacture of saws and knives were represented, including lumber manufacturers, woodworking industries, saw and knife manufacturers, machinery manufacturers, a woodworking journal, and woodworking engineering specialists. It was the consensus of opinion that the proposed program is very much needed.

The National Machine Shop Practice Meeting

THE Cincinnati Local Section acted as host on the occasion of the enjoyable National Machine Shop Practice Meeting, September 24 to 27. The most successful event of the meeting was the trip on the steamer *Cincinnati* up the Ohio River to Ashland, Ky., to visit and inspect the remarkable continuous-sheet mill of the American Rolling Mills Company.

Over two hundred members and guests were on the *Cincinnati* when she steered out into the river on Monday. The Local Section had arranged various deck sports, with prizes for the winners. The joy of the sports, the fine weather, and the wonderful spirit of good-fellowship made the meeting a memorable one.

Two technical sessions were held on the boat, and one at the hotel in Cincinnati after the boat trip. The meeting also included inspection of many interesting plants in Cincinnati.

At Ashland, the Armco organization entertained the visitors in splendid fashion, providing a guide for each group of four persons. The guides were all men of responsibility in the plant, and their knowledge of the operations made the visit very enjoyable and most informative. The engineers were the guests of Armco at luncheon, after which informal addresses were made by J. C. Miller, vice-president of the company, in charge at Ashland, Bennett Chappelle, vice-president, E. A. Muller, vice-president of the A.S.M.E., Ralph Flanders, member of the A.S.M.E. Council, and L. C. Morrow, chairman of the Machine Shop Practice Division.

At the first technical session held on the steamer, W. H. Roughley, of the Wright Aeronautical Corporation, Paterson, New Jersey, presented a paper on "Inspection Methods and Control of Quality in the Manufacture of Parts for Aircraft Engines." Ralph E. Flanders presided at the session, and in commenting on the paper called attention to the fact that while in the machine-tool industry they were trying to reduce the number of special steels used, it was noticeable that in the manufacture of aircraft engines a large number of special alloys must be used to produce a high type of engine.

Erik Oberg, editor of *Machinery*, commented on the growth of

the aircraft industry and its present developing into a mass-production industry. What seemed to be retarding the industry from going into the mass production of airplanes had been the inability to obtain medium-powered engines in sufficient quantity. Mr. Oberg quoted from papers presented at an aeronautical meeting of the Society held in Wichita, Kan., September 21 and 22.

The second session of the meeting was held on the return boat trip on the evening of September 25. L. C. Morrow, managing editor of *American Machinist* and chairman of the Division, presided. The first paper was on "Some Theories of Bearing Lubrication," by Forrest E. Cardullo, chief engineer, G. A. Gray Company, Cincinnati, Ohio. Mr. Cardullo's paper was extensively discussed by H. A. S. Howarth, W. H. Herschel, Mayo D. Hersey, chairman of the Lubrication Research Committee of the Society, Prof. E. O. Waters and G. B. Karelitz.

In general, the discussion developed considerable differences of opinion. Professor Waters stated that Mr. Cardullo had discarded the classical analysis and followed a distinctly different line of reasoning, basing his equations on the assumption that the pressure in the bearing was caused entirely by axial motion of the fluid. The method followed by Reynolds, Sommerfeld, and others assumed that the fluid motion was wholly tangential. Obviously, both lines of reasoning were open to criticism: the classical method neglected the end leakage that occurs in all bearings and is critical in very short bearings, and Mr. Cardullo's analysis gave excessively high pressures for bearings of great length.

The second paper was on "Grooving Bearings for Machine Tools," by G. B. Karelitz, Research Department of Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. The paper was discussed by G. C. Hazard and F. E. Cardullo.

At the third session, held at the hotel in Cincinnati, the symposition on machine tools and their uses in large industries, brought out considerable interesting discussion on new cutting devices and new alloys. Walter W. Tangeman, of the Cincinnati Milling Machine Co., and member of the Executive Committee of the Machine Shop Practice Division, presided. The papers were as follows: "The Automotive Industry," by L. L. Roberts; "The Electric Industry," by J. R. Weaver; "The Agricultural-Implement Industry," by Max Sklovsky; and "The Railroad Industry," by L. A. North.

The Second National Fuels Meeting at Cleveland

Excellent Technical Program With Sessions on Fuels Characteristics, Industrial Uses, Heat-Transfer, Pulverized Coal, Refractories and Stokers, Railroads and Smoke Abatement

A NOTEWORTHY position of national prominence in matters relating to fuels was assured to the Fuels Division as a result of the successful Second National Fuels Meeting held at the Hotel Cleveland, Cleveland, Ohio, September 17 to 21. More than seven hundred in attendance at the sessions and inspection trips—engineers of wide reputation from all parts of the country—attested to the widespread interest in the program of technical papers and events, and the enthusiastic comments which were heard were an indication of the benefits derived by those taking part in the proceedings.

Conspicuous among the features of the technical program was the interest shown in smoke abatement, as well as that in the use of fuels for boiler-furnace and industrial-furnace firing.

President Baker on Research

The broad purposes and aspirations of the Fuels Division were fittingly characterized by Thomas S. Baker, president of the Carnegie Institute of Technology, Pittsburgh, in an address entitled "The Perils and Profits of Research." Research, President Baker said, was a curse to those who did not employ it, and a blessing to those who did. It was the means by which our national wealth could be increased by increasing the intrinsic value of raw materials. The application of the results of researches in coal chemistry to the products of the mines of America should prove a tremendous boon to the coal industry. Researches should be undertaken, he said, through the cooperation of the coal companies and the universities, and a program should be worked out and financed in a broad, far-reaching matter. Results already attained in the processing of coal and its use as the raw material for many important industries were pointed to by President Baker as showing the possibilities which the future holds for increasing the value of this natural resource and for improving the condition of the industry which is built upon it.

President Baker's address, which appears as the leading article in this issue, was delivered at the opening session of the meeting. Victor J. Azbe, chairman of the Fuels Division, and tireless and far-visioned worker for the Society's national prominence in this field, sounded the keynote of the Division's hopes in his opening address at the same session.

Session on Fuels Characteristics

The extensive program, although spread out over four days, necessitated simultaneous technical sessions almost every day. The first of these was held on Monday afternoon when papers on "Constitution and Classification of Coal," by A. C. Fieldner, chief engineer, Experiment Station Division, U. S. Bureau of Mines, Washington, D. C., and on "Burning Characteristics of Different Coals," by Henry Kreisinger and B. J. Cross, research engineers, Combustion Engineering Corporation, New York, N. Y., constituted the session on Fuels Characteristics, and papers on "Progress Toward Direct Firing of Boilers With Producer Gas," by W. B. Chapman, president, Chapman-Stein Furnace Co., Mt. Vernon, Ohio, and on "Washing and Preparation of Coal," by H. D. Smith, assistant to the president, Majestic Collieries Co., Bluefield, W. Va., were delivered at a general session. E. R. Fish, Vice-President of the Society, acted as chairman at the former session, and John Van Brunt, of the Executive Committee of the Fuels Division, at the latter.

Mr. Fieldner's paper was in effect a progress report of a sectional committee of the American Engineering Standards Committee on the classification of North American coals. The outstanding problem which faced the sectional committee was how to reconcile the different points of view of the scientific, engineering, and commercial groups in working toward the common

goal of a uniform and adequate system of classification. Mr. Fieldner reviewed the work of scientists and technologists who have attempted classifications, and summarized the program of the sectional committee as follows:

1 Coal should be classified primarily on the basis of its intrinsic chemical and physical properties. These properties involve the origin, composition, and constitution of the coal.

2 Use classification should be secondary to scientific classification, and should be correlated with the scientific classification as far as possible.

3 Scientific classification depends on two primary factors; first, the composition and type of the original coal-forming vegetation, and second, the degree of metamorphism or coalification of the vegetable residue.

4 The first factor is described broadly in the type of the coal, as xyloid, canneloid, or boghead; the second factor in the progressive rank of the coal as expressed in the series from lignite to anthracite.

5 The criteria to be considered for classifying under these two general factors are proximate and ultimate analyses, calorific values, microscopic examination, extraction with solvents, reaction with reagents, and destructive distillation.

He closed with a plea for support and cooperation.

The paper by Kreisinger and Cross presented a valuable résumé of the burning characteristics of different coals mined and used in the United States. The appearance and physical and chemical characteristics of the well-known coals ranging from the graphitic anthracite of Rhode Island to the lignites and peats of the southern and western fields were clearly described in the paper, and their burning characteristics on various types of grates and stokers as well as in pulverized form were carefully considered.

General Session, Monday

The two papers at the general session stimulated an interesting discussion. W. B. Chapman's paper on the direct firing of producer gas in boiler furnaces presented the advantages of this method of firing, and contained the prediction that some day boilers will be fired with producer gas. Mr. Chapman listed the five principal improvements which must be made before gas producers will be suitable for providing gas for large boiler furnaces, as follows:

1 Producer capacities must be increased to 100 lb. per sq. ft. per hr.
2 Producers must be suitable for location under or within the boiler
3 Producers must handle slack coal
4 Producer fire beds must require no hand poking
5 The present proportion of steam required in the air blast must be greatly reduced

After discussing these improvements he concluded that the proposed application of producer gas was a practical possibility and would be an accomplished reality within a few years. The paper was presented, he said, in the hope of stimulating research along the lines suggested.

While the washing and preparation of coal is more of a mining than a utilization problem, the effect of proper methods at the mine on the utilization at kiln and furnace is important to fuel and combustion engineers. Mr. Smith's paper was therefore interesting and helpful in presenting this phase of the fuels problem. Methods of washing and preparing coal were described, and the cost of cleaning was discussed. Mr. Smith also showed how mining methods at the face affected the quality of coal shipped. If the consumer understood the value of an efficiently cleaned coal, better returns from cleaning plants could be obtained, he said. There were no data at present that would give an operator a knowledge of the effect of coal cleaning on marketability.

Industrial and Heat-Transfer Sessions

At the industrial session on Tuesday morning two papers were presented which were received too late for preprinting. The authors made able presentations, and valuable discussion was drawn from the audience. While the industrial uses of fuels have generally received less attention than their utilization in boiler furnaces, the Fuels Division is actively interested in this broad and important field and is eager to stimulate further work in it.

The first paper was by James H. Herron, Cleveland, Ohio, on "Industrial-Furnace Efficiency—Economic Considerations," and the second by W. E. Rice, of the U. S. Bureau of Mines, Pittsburgh, Pa., on "The Use of Fuels in Tunnel Kilns." McRae Parker, mechanical engineer of the Cleveland Worsted Mills Co., Cleveland, Ohio, was chairman of the session.

At the heat-transfer session, at which Dr. H. S. Booth, assistant professor of chemistry, Western Reserve University, acted as chairman, Dr. R. E. Hall, director, Hall Laboratories, Pittsburgh, Pa., summed up the situation as regards water conditioning in a paper entitled "Present Tendency of Boiler-Water Conditioning." For those who might question the propriety of such a paper at a fuels conference, the committee can point to an extremely interested audience and extended discussion, and to the importance of clean boiler surfaces in the problem of making steam by burning fuel.

A. C. Danks, president and treasurer, Ashmead-Danks Company, Cleveland, Ohio, read the second paper, entitled "Recent Developments and Improvements in the Baffling of Vertical Boilers." Mr. Danks' paper contained numerous examples of the use of cross-baffles in the Stirling and other types of vertical boilers. Test results were included in the paper.

Powdered-Fuel Session

Alfred D. Blake, associate editor of *Power*, New York, presided at the powdered-coal session on Tuesday afternoon, at which three papers were discussed.

Lincoln T. Work, of the Department of Chemical Engineering, Columbia University, New York, took up the question of "Fineness of Pulverized Fuel as Affected by Mill Types." Dr. Work's paper showed photomicrographs of samples of coal taken from different types of mills. Hammer mills produced relatively coarse coal with but little superfines, roller mills produced widely differing fineness depending upon specific mill action and upon plant conditions, and tube mills normally produced coal low in sieve mesh and high in superfines. Dr. Work also described his turbidimetric method for measuring superfines.

One of the problems which has assumed importance through the introduction of pulverized-fuel firing is that of chimney dust. While this is allied in the public interest with the smoke-prevention problem, its solution appears more difficult. Hence the paper by K. Toensfeldt, engineer, Combustion Engineering Corporation, New York, on "Collecting the Dust From Chimney Gases of Powdered-Fuel Installations," was of unusual interest. Mr. Toensfeldt described the present state of the art and some of the solutions offered, and listed types of equipment used.

The third paper presented at this session was by John Blizard, head of the research department, Foster-Wheeler Corporation, New York, on the "Unit System of Coal Pulverizers for the Generation of Steam." After sketching the general features which distinguish the unit from the central system, Mr. Blizard discussed the principles involved in burning the coal with unit systems and points in burner and furnace design.

General Session, Tuesday

Prof. Fred H. Vose, of the Department of Mechanical Engineering, Case School of Applied Science, Cleveland, Ohio, acted as

chairman at the general session on Tuesday afternoon. A plea for research in fuels under the procedure of the A.S.M.E. was made by F. R. Wadleigh, consulting engineer, New York, in a paper entitled "Possible Avenues of Productive Research on Coals." At the same session F. M. Van Deventer, mechanical engineer, construction department, Henry L. Doherty & Co., New York, delivered a paper on "The Determination of Economic Value in the Selection of Power-Plant Equipment." After reviewing the customary procedure in obtaining competitive bids on equipment, Mr. Van Deventer discussed critically the commonly used criteria of relative value. He then drew definite conclusions concerning the correctness and merit of each. Finally he presented two illustrative examples to demonstrate his conclusions, and summarized the recommended method.

Refractories and Stokers Session

One of the most largely attended sessions of the meeting was held on Wednesday morning and was devoted to refractories and stokers. Every bit of available space was occupied, and many were forced to stand in the doorways, so popular proved the subjects under discussion. L. A. Quayle, chief mechanical engineer, Department of Public Utilities, City of Cleveland, served as chairman.

Through unpreventable delays, the first paper, by C. F. Hirshfeld, chief, research department, and W. A. Carter, technical engineer, power plants, Detroit Edison Company, Detroit, Mich. entitled "Boiler-Furnace Refractories," had not been prepared in time for preprinting. Dr. Hirshfeld made an extremely interesting presentation of the subject, giving the results of tests made with various types of firebrick and furnace-wall construction. His subject was one of very live interest and gave rise to many questions and considerable discussion. He was followed by Theo. Maynz, consulting engineer, Cleveland, whose paper, "Stoker Advantages and Difficulties," was the frank expression of opinion of an engineer whose personal experience with stokers has left him with vivid impressions. The discussion which he had hoped to provoke was as lively and frank as the paper had been. No matter on what side of the question a listener might have found himself, the discussion provided ample food for thought and no little entertainment.

Marine Session

On Wednesday morning there was a session devoted to marine uses of fuels. Two papers were presented, one by T. B. Stillman, Babcock & Wilcox Co., New York, on "Pulverized-Coal Firing of Marine Boilers," and the other, by George A. Richardson, Bethlehem Steel Co., Bethlehem, Pa., on "Oil Firing of Marine Boilers." A. H. Johnson, editor *Marine Review*, Cleveland, acted as chairman.

Railroad Sessions

The use of fuels on the railroads was covered in two sessions, Wednesday morning and afternoon. E. H. Kuhn, Engineer of Motive Power, N.Y.C. & St. L. R.R., Cleveland, presided. At the morning session, J. M. Clark, chief fuel supervisor, Southern Pacific R.R. Co., San Francisco, presented a paper on "Railway Practices in Utilization and Conservation of Oil," and Malcolm McFarlane, New York Central R.R. Co., New York, presented one on "Selection and Use of Fuels in Locomotive Practice."

Mr. Clark's paper first reviewed the early experiments made in 1879 by the Central Pacific R.R., now part of the Southern Pacific Lines, and later in 1894, in the utilization of oil on locomotives. Following the specifications for oil laid down by railroads the author discussed methods of delivery and storage, fire hazard, locomotive equipment, and methods of firing. The final portion of the paper was devoted to a discussion of recent improvements in railroad power equipment, fuel-economy devices, increase in locomotive runs, and stationary boilers.

Mr. McFarlane described a system for indicating relative physical and analytical values of railroad coals. The New York Central Lines, he said, were obtaining excellent results by regularly assigning the same grade of coal to a particular service.

At the afternoon session, John G. Crawford, fuel engineer, C. B. & Q. R.R. Co., Chicago, Ill., read a paper on "Relative Values of Different Sizes of the Same Fuel in Locomotive Service," basing his conclusions on work done at the University of Illinois, and on the results of a questionnaire to the various railroads. W. J. Overmire's paper was entitled "Railway Practice in Utilization and Conservation of Coal."

Central-Station Session

The central-station session, held on Wednesday afternoon, drew a large audience and was productive of much interesting discussion. The chairman was James C. Hobbs, superintendent of power, Diamond Alkali Co., Painesville, Ohio.

The first paper discussed modern stokers. It was entitled "Development and Recent Design of Stoker-Fired Equipment for Steam Generation," and was prepared by Joseph G. Worker, assistant to the president, and Joseph S. Bennett, mechanical engineer, American Engineering Company, Philadelphia, Pa.

The other papers dealt with pulverized fuel, pulverized-fuel burners, and furnaces. E. H. Tenney, chief engineer, power plants, Union Electric Light and Power Co., St. Louis, Mo., summarized the experiences at the Cahokia Station from the standpoints of performance and dollar value in a paper entitled "Progress in Central-Station Use of Pulverized Coal." Using as examples several recent pulverized-coal plants, E. G. Bailey, president, Fuller-Lehigh Co., Fullerton, Pa., read a paper on "Present Status of Furnace and Burner Design for the Use of Pulverized Fuel." After a brief description of these plants, Mr. Bailey listed the specification for a good pulverized-fuel burner and discussed the factors which must be considered before any burner can be properly designed and operated.

Smoke-Abatement Session

The last day of the meeting was given over to smoke abatement. The morning session was presided over by Col. E. H. Whitlock, smoke commissioner, City of Cleveland. The first paper dealt with the economic phases of the smoke nuisance and contained a wealth of information on this subject. It was by H. B. Meller, commissioner of smoke abatement, Pittsburgh, Pa., and director of smoke-abatement research, Mellon Institute of Technology. Mr. Meller's paper is to appear in a subsequent issue of MECHANICAL ENGINEERING. Victor J. Azbe, consulting engineer, St. Louis, Mo., read the second paper, on "Smokeless and Efficient Firing of Domestic Furnaces, Part II." Part I of this paper was presented at the First National Fuels Meeting held a year ago in St. Louis. The author gave the results of his tests on smokeless operation of domestic furnaces and on various types of furnaces, with comments on their effectiveness in preventing smoke. He called attention to the necessity of considering the CO_2 content and the excess air in reporting smoke densities. His paper included a discussion of several so-called smoke-prevention devices offered to the consumer for attachment to domestic furnaces.

After a luncheon conference of those interested in smoke-prevention work, the afternoon session, at which W. G. Christy, of St. Louis, secretary of the A.S.M.E. Fuels Division, presided, was given over to the organization and administrative aspects of smoke abatement. H. K. Kugel, deputy smoke commissioner, Cleveland, presented a discussion of "Problems and Methods in

Smoke-Abatement Work," which was based on experiences and practices in the city of Cleveland. Following this there was a discussion and general conference in which many took an active part.

In many ways, smoke abatement was one of the most important aspects of the Fuels Meeting. It was brought out that a tremendous problem awaits solution here and that the Society has a wonderful opportunity to serve the country and the profession by a more active study of it. There appeared a very real need for such information as the procedure and organization policies of various cities so that those just starting in such work may have a guide for their activities, and there was brought out the value of collecting reliable test data on smoke-prevention furnaces and appliances which could be furnished through a central agency to smoke commissioners all over the country, with a tremendous saving in avoiding duplication of effort in individual tests.

If the Second National Fuels Meeting accomplishes nothing else, it has served as a stimulus to the Division to take up more actively this acute problem. Plans are already being developed by the executive committee of the Division, and the hope has been expressed that at the National Fuels Meeting next year considerable progress on an extensive program will be announced.

Entertainment

Among the high points of excellence of the meeting at Cleveland, those who attended will long remember the superior quality of the entertainment features which made it an unusually enjoyable occasion. Too much credit cannot be given Mr. A. G. Shelley and his splendid committee.

The smoker on Monday evening took the form of a vaudeville entertainment in which clever performers kept the audience awake and amused. The singing and dancing were of a high order, and did credit to the discrimination of the committee.

A buffet supper following the entertainment gave occasion for a general mingling of the members and guests present, the renewal of old acquaintances, and the formation of new ones.

Tuesday night's dinner and dance fulfilled the expectations which Monday night's performance had raised. During dinner an orchestra played and vocal soloists sang some familiar songs. An effective feature was the presentation of roses to the guests by several attractive girls who walked among the tables with their well-filled baskets of red blossoms.

Col. E. H. Whitlock, chairman of the general arrangements committee, introduced the toastmaster of the evening, Mr. Charles Adams, of Cleveland. The speakers were Hon. William R. Hopkins, city manager of the city of Cleveland, and William B. Stout, of the Stout Air Services, Inc. Both speeches possessed the qualities of brevity and wit, and both were convincing. The city manager's conviction of the importance of the work of the Fuels Division was extremely gratifying. A picture of the future as affected by aviation was sketched by Mr. Stout. Speechmaking was followed by dancing, which continued until after midnight.

A second dance, held with the Cleveland Engineering Society at Log Cabin, Euclid Beach Park, was the entertainment feature of Wednesday evening. In spite of a rainstorm the evening was thoroughly enjoyed by guests and members and the occasion maintained the high average of excellence which marked all the social events.

Ladies' Program

Judging from attendance at the technical sessions, the ladies present at the Second National Fuels Meeting were not interested primarily in fuels, although a few were seen at some of the sessions on smoke abatement. Recognizing this in advance, a program of entertainment had been prepared by the Ladies' Committee under the chairmanship of Mrs. R. H. Danforth.

The events scheduled commenced with a card party at the Hotel Cleveland on Monday night which paralleled the men's smoker. Tuesday morning was taken up with an inspection of the Cleveland Public library and the Bell Telephone Building, luncheon being served at the Women's City Club of Cleveland.

The afternoon was spent at the Clifton Club where there was tea and music. The ladies were of course the most important part of the dinner on Tuesday night, and of the dance at the Log Cabin on Wednesday night. Wednesday morning was spent in a drive about the city, with luncheon later at the Canterbury Country Club, and there was a trip in the afternoon to Nela Park of the General Electric Company. About seventy ladies were registered at the meeting, forty of whom were from out of town.

Plant Visits

Under the active chairmanship of W. G. Stephan, plant visits of unusual interest were arranged during the meeting for those who wished to take advantage of a few days in Cleveland to visit some of its well-known points of interest to the fuels engineer. It was unfortunate that an extensive program made it necessary to schedule plant visits simultaneously with technical sessions, so that visiting members were frequently torn between two desires.

On Monday afternoon the Fairmount Pumping Station of the Cleveland Water Works was visited. This is a modern pumping station and filtration plant and is equipped with turbine-driven pumps. It is peculiar in that the drives in the boiler room are by water turbine instead of by the usual steam turbine.

For those interested in pulverized fuel, the visit to the Avon Station of the Cleveland Electric Illuminating Company was greatly enjoyed. This modern power plant contains six 3060-hp. Stirling W-type boilers fired with pulverized coal and three 35,000-kw. turbo-alternators. Steam is generated at a pressure of 375 lb. per sq. in. and at 700 deg. fahr. total temperature.

An extensive trip with varied interests was enjoyed on Wednesday afternoon through the courtesy of the American Steel and Wire Company. Luncheon was provided on the special train which proceeded to the central furnaces and docks. Here the ore boats are unloaded. The plant consists of four furnaces which are blown by two gas-engine-driven and seven steam-engine-driven blowers. Gas-engine-driven and turbo-generators supply electrical energy to this works and to a system supplying Cuyahoga Works, Coke Works, Newburgh Steel Works, and Newburgh Wire Works.

From here the train carried the party to the Cuyahoga Works, where there are four hot-strip mills finishing 1-in. to 20-in. widths and a rod mill rolling mostly No. 5 rods. The finishing departments include cold-rolling machines producing strip from $^1/_2$ in. to 25 in. wide, core wire drawing blocks, bale-tie machines, galvanizing equipment, patenting furnaces, box-type annealing furnaces, and an electric annealing furnace.

Cleveland is justly proud of a modern airport and a passenger airline to Detroit which reduces the transportation time between these important cities to 100 minutes. The excursion on Thursday afternoon was to this airport where special flying manuevers had been arranged. Some members availed themselves of the opportunity of flying in the tri-motored Ford-Stout planes, while others left for Detroit by way of the regular passenger planes of the Stout Air Services, Inc. An unexpected feature of the trip was the arrival of Colonel Lindbergh on a visit to Ambassador Herrick, which gave many visitors an opportunity to see him at close hand and in the air.

National Metal Exposition in Philadelphia

DURING the week of October 8 the tenth annual convention of the American Society for Steel Treating was held in Philadelphia simultaneously with the tenth annual National Metal Exposition, the fall meeting of the Institute of Metals Division of the American Institute of Mining and Metallurgical Engineers, and the fall meeting of the American Welding Society. Taken as a whole an unusually large and valuable amount of information on applied metallurgy and the state of its actual development was presented. Some of the papers read will be abstracted later in MECHANICAL ENGINEERING. The National Metal Exposition, however, deserves particular mention.

Of late there have been numerous exhibitions of this kind, and apparently considerable progress is being made in handling the problems which they present. For obvious reasons, however, this is not a simple matter. In the case under consideration practically all of the machinery was distributed along aisles running the length of the hall of the Commercial Museum in Philadelphia, and only very few exhibits were placed crosswise. This not only made the hall look better and less crowded, but also permitted a quicker and more complete survey of the various showings.

With one or two exceptions, very little that is radically new was shown, but the extensive displays served to indicate the high state of development which various products and machines have attained. Because of lack of space only a few of the exhibits can be mentioned here—principally those of particular interest to the majority of mechanical engineers.

The Air Reduction Sales Co. exhibited several types of apparatus for the oxyacetylene cutting of steel plates, risers, etc., both for straight-line and circle cutting. Some of these were equipped with a motor-driven tracing mechanism for following patterns or templets. An apparatus was also shown for the reproduction cutting of shapes from steel plate.

An automatic nut-tapping machine was shown by the Automatic Nut Thread Corporation, of Philadelphia.

The Edward G. Budd Manufacturing Co., of Philadelphia showed a number of examples of difficult automobile body stampings made from a single sheet of steel, as well as examples of recent developments in various forms of spot welding. It was stated at the exposition that examples of new methods of rolling would be also shown, but these were not in evidence on the first day.

Steel case-hardened by nitration has been attracting considerable interest of late, and examples of it were shown by the Central Alloy Steel Corporation.

The Climax Molybdenum Co. staged an interesting educational exhibit showing molybdenum ore as it occurs, together with the concentrates produced from the ore and various forms in which it is prepared for use by the iron, steel, and industrial trades.

Numerous welding outfits were shown. The general impression which they created was that the art of welding has already been brought to a high state of development. Of particular interest, because of its new principle, was the atomic-hydrogen welding unit shown by the General Electric Co. This type of welding is somewhat more expensive than other forms of electric welding, but is particularly suitable for welding certain special alloys, and thin metal generally.

The Gray Iron Institute, formed last spring, distributed a leaflet from its booth which stated that it is generally admitted that gray-iron castings have not sustained their rightful prestige in industry, and promised to correct, as far as possible, the ills affecting the business of gray-iron makers. Among the major activities of the Institute will be the giving of publicity to recent developments in gray iron, developments of a standard grading or classification of gray iron, supporting and introducing research work directed toward improving the quality of gray iron, etc. The adoption of a uniform code of ethics or trade customs clarifying the relations between the buyer and seller is also listed.

The Keller Mechanical Engineering Corporation showed an automatic toolroom machine equipped with a double tracer rigging. This latter is a comparatively new development by means of which three-dimensional work can be produced on the machine from a combination of outline and depth templets or models.

The Guthrie-Leitz grinding and polishing machine (E. Leitz Co.) exhibited a labor- and time-saving device which permits the simultaneous preparation of three specimens in the time formerly required for one.

The New Departure Manufacturing Co. had a very clever exhibit. It consisted of an opening through which a ball fell on an elastic steel strip. The ball rebounded from this strip, struck another similar one, again rebounded and went through another hole in a vertical partition. As the angle and height of bound were controlled exclusively by the weight of the ball or balls falling from the same elevation, the exhibit gave an idea of the striking uniformity in size and weight which modern ball-manufacturing methods have effected.

Quite a number of more or less new cutting metals were exhibited. Of these may be mentioned Carboloy, a tungsten-base metal said to possess great hardness.

The Norton Co. showed several new developments in grinding wheels, such as segmental wheels, a special chuck for the Blanchard machine, and a machine designed especially for high-speed work.

The Shenango-Penn Mold Co. showed centrifugally cast bronze in various sizes and forms, such as rings, bushings, etc., semi-finished and finished.

The Sleeper & Hartley Co. had in operation a universal spring-coiling machine. The most interesting feature of this machine was the ease and rapidity with which it could be changed to produce springs of various types and shapes.

The Smith Welding Equipment Co., among other things, exhibited a welding torch especially designed for the welding of aircraft fittings, fuselages, and the like. With a medium-sized tip assembly the torch has an overall length of 12 in. and weighs only 8 oz.

The Surface Combustion Co. showed heat-treating and similar furnaces. They distributed a leaflet giving particulars of a furnace for the continuous normalizing of full-finished automobile sheets. The heat cycle of this furnace is as follows: Sheets enter at room temperature and leave the heating zone at 1750 deg. fahr. They are then held at 1500 deg. fahr. for a short time before finally cooling to 100 deg., the temperature at which the sheets leave the furnace. The furnace is 102 ft. long with a 15-ft. preheat zone, 45-ft. heating zone, and 34-ft. cooling zone. The fuel consumption per pound of steel is $1^1/_2$ cu. ft. of natural gas with a heat content 1000 B.t.u. Thus far only one furnace has been installed.

One of the most interesting exhibits was that of Temple University, descriptive of its classroom and laboratory courses in metallography and heat treatment.

The Westinghouse Electric & Manufacturing Co., among other things, had a match-vending machine operated by a grid glow tube, as well as a delineascope showing installations of Westinghouse furnaces.

Book Reviews and Library Notes

THE Library is a cooperative activity of the A.S.C.E., the A.I.M.E., the A.S.M.E. and the A.I.E.E. It is administered by the United Engineering Society as a public reference library of engineering and the allied sciences. It contains 150,000 volumes and pamphlets and receives currently most of the important periodicals in its field. It is housed in the Engineering Societies Building, 29 West 39th St., New York, N. Y. In order to place its resources at the disposal of those unable to visit it in person, the Library is prepared to furnish lists of references on engineering subjects, copies of translations of articles, and similar assistance. Charges sufficient to cover the cost of this work are made.

The Library maintains a collection of modern technical books which may be rented by members residing in North America. A rental of five cents a day, plus transportation, is charged. In asking for information, letters should be made as definite as possible, so that the investigator may understand clearly what is desired.

International Electrotechnical Commission Reports

TWO volumes containing the papers and reports presented at the Bellagio meeting of the International Electrotechnical Commission have been presented to the A.S.M.E. by the United States National Committee of the I.E.C. These reports cover the following subjects:

Volume I, Rating of Electrical Machinery, Symbols, Prime Movers (Steam and Hydraulic), and Lamp Holders and Bases

Volume II, Standard Voltages, Traction Motors, Insulating Oils, Rules and Regulations for Overhead Transmission Lines, Radio Communication, Measuring Instruments, Rating of Rivers, and Terminal Markings.

They are available to any member of the A.S.M.E. who desires to refer to them. Copies have also been placed at the disposal of the American Institute of Electrical Engineers, American Society for Testing Materials, National Electric Light Association, National Electrical Manufacturers Association, United Engineering Societies Library, American Engineering Standards Committee, Department of Commerce, and the office of the Secretary of the U. S. National Committee, Room 1018, 33 West 39th Street, New York, N. Y.

Standards and Standardization

Standards and Standardization. By Norman F. Harriman. McGraw-Hill Book Co., Inc., New York, N. Y. Cloth, 6 × 9 in., 265 pp., illus., $3.

Reviewed by Collins P. Bliss[1]

IN THIS intensely utilitarian age, Mr. Harriman's book in the first chapter reminds the reader that creative ability as exemplified in the early guilds among artisans of that day did not die but lived to benefit the masses because repetition work demanded genius in providing greater interchangeability, and the latter leads directly up to the idea of standardization. His discussion of the evolution of standards points out that hand in hand with the demand for automatic operation evidenced by improvement in processes of manufacture, goes the natural sequence of the elimination of waste.

Today the policies and methods set up in industry to eliminate the duplication of parts, the unnecessary multiplicity of sizes and weights, and the useless employment of manual effort are a strong endorsement of the timely publication of a book which will direct the reader to a formula which will solve these problems.

This formula is "Standardization;" and what standards are, how they can be set up and are being used and their economic value to consumer and producer, form the subject matter of Mr. Harriman's nine chapters so logically arranged and presented.

The foundation of all standardization, especially dimensional, must be based on the element of precision, which in turn must have an ultimate single standard in each field of comparison, than which there can be none more perfect.

What these are in units of length, mass, and time, together with the application of these units to the measurement of qualities possessed by mechanical products and processes, naturally follow in the development of a subject where each step in the production of a standard is as important as the individual link in any chain.

The purpose of the foregoing is very ably presented in one paragraph, as follows:

> To secure high utility in the products of industry by setting an attainable standard of quality;
> To furnish a scientific basis for fair dealing to avoid disputes or settle differences;
> To promote truthful branding and advertising by suitable standards and methods of test;
> To promote precision and avoid waste in science and industry by affording quality standards by which materials may be made, sold, and tested.

The act of standardizing means more in results than the setting up of a standard. In the following sentence the author briefly and aptly sets this forth. "It is the crystallization of the best thought and practice of industry, business or art into definite forms for general use." Again, he says, "The idea of perfection is not involved."

No standard is set for all time, and if it were, all progress would stop. Even in the process of standardization in any field, particularly where time, tests, and research have to be considered, the standard is frequently changed materially from what seemed to be a general consensus of opinion at the start to new agreements based on the progress of the art during the formulation of the standard.

The advantages of standardization as presented in the middle chapters of the book ought to inspire a desire to read it through to the end in order to find out what benefit a particular reader might secure by possessing a comprehensive knowledge of what standardization might do for him. It certainly ought to create a willingness at least to do his bit in cooperating with those who feel that the establishment of sound standards is a step forward in American industrial history.

The author clearly sets forth the relationship of quality specifications in the chapter on Standardization of Quality.

[1] Associate Dean, College of Engineering, New York University. Chairman, Standardization Committee of A.S.M.E.

In fields where keen competition exists, industry is seeking lower prices and greater efficiency.

Definite specifications that can be lived up to and that can tell the purchaser not only what he wants to know, but what will best suit his needs, should be based on universally accepted standards in any particular field.

Finally, the machinery for producing "American Standards" is briefly and succinctly explained in relation to the national and international standardizing bodies. These bodies endeavor, through interlocking committees, to decide what shall be standardized, how it shall be done, and when.

The definite procedure is described and organization charts presented showing how the whole process of standardization functions under the American Engineering Standards Committee (A.E.S.C.), soon to be known as the American Standards Association (A.S.A.).

"Standards and Standardization" ought to prove a work of distinct value to those associated in any way with American industry, and if America is not industrial, what is it?

Books Received in the Library

DIE ABWÄRMETECHNIK. By Hans Balcke. Vol. 2. R. Oldenbourg, Munich and Berlin, 1928. Cloth, 6 × 9 in., 198 pp., illus., diagrams, 11.50 m.

The first volume of this work on waste-heat engineering discussed the industrial sources of waste heat and the conditions under which it could be utilized profitably for generating steam, heating, or distilling. In this second part the constituent parts of plants for utilizing waste heat are described, with the methods of assembling them and connecting them to the heat-producing and heat-utilizing apparatus. The methods of using waste heat in engines, furnaces, feedwater heaters, turbines, etc., are set forth.

ACETATE SILK AND ITS DYES. By Charles E. Mullin. D. Van Nostrand Co., New York, 1927. Cloth, 6 × 9 in., 473 pp., illus., tables, $6.

This treatise for the dyer of textiles is concerned with one of the two divisions of artificial silks, that in which the fiber is chemically a cellulose ester. The cellulose acetate silks, the commercial representatives of this class, differ widely in chemical properties from the regenerated cellulose silks and from cottons, notably in their reactions to dyes. Entirely new dyes and methods of dyeing have had to be devised.

In this volume, the author gives a comprehensive account of the work done in this field, chiefly in very recent times. The dyes that are suitable are described and the processes of dyeing are given in detail. The book brings together the widely scattered information available and arranges it in convenient form for study and reference.

ANALYTISCHE GEOMETRIE DER EBENE. By Robert Haussner. Walter de Gruyter & Co., Berlin and Leipzig, 1928. Cloth, 4 × 6 in., 164 pp., diagrams, 1.50 r.m.

An introductory textbook on plane analytic geometry, which is intended to give the beginner the general theory of curves of the first and second degrees in full, as well as that for a considerable number of special cases. In spite of extreme condensation the text covers a wide range in a clear manner.

DIE ANWENDUNG DER INTERFEROMETRIE IN WISSENSCHAFT UND TECHNIK. By E. Berl and L. Ranis. Gebrüder Borntraeger, Berlin, 1928. (Fortschritte der Chemie, Physik und physikalischen Chemie, Band 19, Heft 7.) Paper, 6 × 10 in., 52 pp., diagrams, 5.20 m.

The interferometer is finding increasing use in analytical work, particularly in works laboratories where control analyses must be repeated constantly, and where speed, ease of operation, and accuracy, are important. This monograph describes the instrument and calls attention to the various fields of work in which it might be found useful.

APPAREILS ET MÉTHODES DE MESURES MÉCANIQUES. By Jules Raibaud. Armand Colin, Paris, 1928. Paper, 5 × 7 in., 215 pp., 9 fr.

A concise description of the methods and apparatus used for measuring the basic quantities of experimental mechanics—time, speed, acceleration, mass, force, work, and pressure. The text is concise and critical. It brings to experimenters in scientific laboratories material that usually must be collected from many different works.

AUFBAU UND ENTWICKLUNGSMÖGLICHKEITEN DER EUROPÄISCHEN ELEKTRIZITÄTSWIRTSCHAFT. By Schwarz, Goldschmidt & Co., Berlin, 1928. Cloth, 7 × 10 in., 511 pp., illus., diagrams, maps, tables.

A detailed economic study of the development and future possibilities of electric-power generation in Europe. The condition of the industry in Germany is covered with great thoroughness and the more important developments in other countries are described. Financial statistics are given for all the important European electrical undertakings. The book will be of great value to those persons who are in need of financial and engineering statistics.

AUTOMATIC TELEPHONY SIMPLIFIED. By C. W. Brown. Isaac Pitman & Sons, New York and London, 1928. Cloth, 5 × 7 in., 168 pp., illus., diagrams, $1.75.

The contents of this volume recently appeared as a series of articles in the Telegraph and Telephone Journal. The Book deals with principles of automatic telephony and gives only a view of the numerous circuits in detail.

BAHNHOFSANLAGEN, Vol. 1. By H. Wegele. Walter de Gruyter & Co., Berlin and Leipzig, 1928. Cloth, 4 × 6 in., 141 pp., diagrams, 1.50 r.m.

Dr. Wegele's book discusses briefly the general planning of railroad stations and terminals, both freight and passenger. Such topics as the situation of stations, the selection of type, the relation of the various parts of stations, track layouts, etc., are treated clearly and concisely. A second volume will treat of buildings.

BALLISTIQUE EXTÉRIEURE, THEORIQUE, Vols. I and II. By G. Sugot. Gauthier-Villars et Cie, Paris, 1928. Paper, Vol. I, 94 pp.; Vol. II, 130 pp.; diagrams, table, 25 fr., 130 fr., respectively.

Professor Sugot here presents the course in ballistics taught at the École d'Application de l'Artillérie Navale. Each volume treats its subject concisely, with emphasis upon practical applications. Together, the volumes form a clear, concise textbook, suited to the needs of artillerymen, and containing the latest developments in the science.

BUSINESS CYCLES, THE PROBLEM AND ITS SETTING. By Wesley C. Mitchell. National Bureau of Economic Research, New York, 1928. Cloth, 6 × 9 in., 489 pp., diagrams, $6.50.

This book takes up current theories of business cycles, present-day economic organizations, the analysis of modern statistical methods and business indexes; gives a summary of world-wide historical records and a working concept of business cycles.

The general plan of this work is similar to an earlier book on the subject by the same author, but the statistical data have proved so extensive that they will be published separately in a series of volumes instead of being included with the theoretical discussions.

COLLOID CHEMISTRY. By The Svedberg. Second edition. Chemical Catalog Co., New York, 1928. (American Chemical Society. Monograph series.) Cloth, 6 × 9 in., 302 pp., illus., diagrams, tables, $5.50.

In 1923 Professor Svedberg gave a series of lectures at the University of Wisconsin in which he presented a general survey of colloid chemistry, with special attention to recent developments in technique. These lectures form the basis of this book, which now appears in a revised and enlarged edition.

The new issue includes accounts of recent advances. More space is given to the results of X-ray analysis, to methods of ultramicroscopy, and other improvements in technique, particularly those developed by the author and his coworkers.

COURS D'AÉRONAUTIQUE. By Émile Leroux. Ch. Béranger, Paris, 1927. Paper, 6 × 10 in., 382 pp., diagrams, tables, 56 fr.

Aeronautics is here presented as taught in the School of Applied Marine Engineering in France. The author, an engineer in the aeronautic corps, has combined in one volume the important data upon all branches of the subject and produced a most satisfactory text. The book is intended for engineers already well grounded in general engineering.

ELEKTRISCHE VOLLBAHNLOKOMOTIVEN, ein Handbuch für die Praxis sowie für Studierende. By Karl Sachs. Julius Springer, Berlin, 1928. Cloth, 8 × 11 in., 461 pp., plates, diagrams, 84 r.m.

The first work in which the electric locomotive is treated comprehensively. The author, engineer of Brown, Boveri & Cie, has aimed to describe the development and present position of the locomotive in a manner that would be of help to all railroad engineers. The text falls in four sections. The first discusses the general questions of traction, train resistance, etc. Section two is devoted to the mechanical part of the locomotive, the framework, trucks, and gearing. Special attention is given to gearing and the coupling of motors to drive wheels. The third section treats of the electrical equipment. Special stress is laid on continuous-current types. The last section describes 15 actual locomotives, selected from those used on various European railroads. The book should be of decided value to any one interested.

ELEMENTS OF AVIATION, AN EXPLANATION OF FLIGHT PRINCIPLES. By Virginius Evans Clark. Ronald Press Co., New York, 1928. Cloth, 6 × 9 in., 193 pp., diagrams, $3.

This volume, by the chief engineer of the Dayton-Wright Co., is an elementary explanation of the principles of aviation intended for beginners in the industry. It aims to explain the principles of flight without resort to complex mathematics and to discuss the broader considerations of airplane structure and design, and thus to serve as an introduction to further study. An unusually good glossary of aeronautical terms is included.

ELLIPTISCHE FUNKTIONEN. By R. König and M. Krafft. Walter de Gruyter & Co., Berlin, 1928. Paper, 7 × 10 in., 263 pp., 13 r.m.

A very satisfactory introduction to elliptical functions. The authors have not attempted a compendious treatment but have produced a textbook which begins with the simplest analytical functions and proceeds, step by step, to the most complex. The treatment develops the subject systematically and organically, and the book equips the student for understanding the classic works in this field.

EVOLVENTENVERZAHNUNG. By Hans Friedrich. Julius Springer, Berlin, 1928. (Theoretische untersuchungen für maschinenbau u. bearbeitung, heft 1.) Paper, 7 × 10 in., 77 pp., diagrams, tables, 7 r.m.

A theoretical and practical treatise on involute gears. The aim is to present clearly and simply the basic principles that underlie the development of involute-tooth profiles and the best methods of cutting involute gears. Among the subjects discussed are the limiting conditions for tooth surfaces, the laying out and cutting of gears, spur and bevel gears, and helical gears.

FRANZÖSISCHER SPRACHFÜHRER FÜR DEN FERNSPRECHWEITVERKEHR. By Albert Lang. Weidmannsche Buchhandlung, Berlin, 1928. Cloth, 6 × 9 in., 120 pp., 9 r.m.

With the rapid extension of international telephony, the language difficulty becomes increasingly troublesome. The author of this work endeavors to facilitate telephony between Germany and France by this dictionary of French and German terms. The first section contains about 550 phrases arranged according to the divisions of telephone service. The second section is a dictionary of French and German technical words, containing all those ordinarily used in telephony.

GETRIEBE UND GETRIEBEMODELLE. Issued by Ausschuss für wirtschaftliche Fertigung. Beuth-Verlag & Julius Springer, Berlin, 1928. Cloth, 6 × 8 in., 192 pp., illus., 6 r.m.

In connection with the Leipzig Technical Fair of 1928 there was displayed an exhibition of the methods available for transmitting or modifying motion in machines. The present book, based on that exhibition, presents photographs of 173 mechanisms, chiefly of models built to illustrate the principles of various devices in common use. The book is an interesting collection of mechanical movements and should prove suggestive to the machine designer.

HANDBUCH DER LANDMASCHINENTECHNIK, vol. 1, part 1. By Georg Kühne. Julius Springer, Berlin, 1928. Paper, 8 × 11 in., 132 pp., illus., 18 r.m.

Previous books on agricultural machinery have been largely descriptive and economic. Much has been written on the machines developed by various manufacturers, and on the value of machinery in farming, but no comprehensive book has appeared in which the design and construction of farm machinery are treated from the point of view of the mechanical engineer.

The present book is the first quarter of a work intended to fill this gap in the literature. It is devoted to machines for working the soil by animal power or by rope drive. It discusses plows, harrows, cultivators, etc., paying special attention to the structural requirements of the various parts, the most suitable materials, and proper design.

ICE ENGINEERING. By Howard T. Barnes. Renouf Publishing Co., Montreal, 1928. Cloth, 6 × 9 in., 366 pp., illus., $5.

Ice is a constant bar to the utilization of northern waters for power and for navigation, so that Professor Barnes' book will be of interest to many engineers. He discusses the laws that underlie the formation of ice, the various kinds of ice, methods of removing ice from power canals and water-works intakes, the prevention of ice floods, ice navigation, and ice breaking. A great amount of information is brought together which has not been readily accessible before, and a useful bibliography is included.

INTRODUCTION TO MODERN PHYSICS. By F. K. Richtmyer. McGraw-Hill Book Co., New York, 1928. Cloth, 6 × 9 in., 596 pp., portraits, tables, $5.

A discussion of the origin, development, and present status of some of the more important classical and modern concepts of physics, intended to give a correct perspective of the growth and present trend of the science as a whole. This perspective is necessary, the author feels, as the basis for intensive study of any subdivision of the subject.

The text first gives a historical review of physics up to 1890, which date is taken as the beginning of the modern period. The

remainder of the book pays attention particularly to the two great problems of today: the reconciliation of the wave theory of light with the quantum theory, and the structure of matter.

LUFTFAHRTFORSCHUNG. Vol. 1, No. 1–4; Vol. 2, No. 1–4. Jan.–Aug., 1928. R. Oldenbourg, Munich, 1928. Paper, 8 × 12 in., illus., diagrams. Various prices, 3.40 r.m. to 6 r.m. each number.

The Wissenschaftliche Gesellschaft für Luftfahrt has begun the publication of this new periodical which will appear at irregular intervals. It will bring together in convenient form reports on the research work done at the Deutsche Versuchsanstalt für Luftfahrt, the Aerodynamische Versuchsanstalt at Göttingen, the Aerodynamische Institut of the Aachen Technical High School, and other centers of research.

The first number reports investigations upon vibration in aerofoils and upon towing tests on floats. Number two describes extensive tests of an aluminum-copper-silicon alloy, lautal, to determine its value as a material for aircraft. Number three reports on the heat treatment of magnesium alloys, on mechanical tests of light-metal tubes, and on a new rope connection. The fourth number contains papers on radio and electrical problems.

The remaining numbers discuss equally important matters. The series will be important to every one interested in the design and construction of aircraft, and to metallurgists and mechanical engineers generally.

MATHEMATISCHE STRÖMUNGSLEHRE. By Wilhelm Müller. Julius Springer, Berlin, 1928. Paper, 7 × 10 in., 239 pp., 18 r.m.

This treatise on the motion of fluids is based on the author's lectures at the Hanover Technical Institute, to students of mathematics, technical physics, and aviation. It occupies a middle ground between the purely systematic and the essentially technical treatment of the subject.

The first portion of the book develops mathematically the theory and the mathematical formulas. The second portion directs attention to practical calculations of the forces on rotating cylinders, the theory of aerofoils and propellers, and the flow in turbines.

LES MESURES DE TEMPÉRATURES COURANTES. By William Dériaz. Ch. Béranger, Paris, 1927. Paper, 5 × 7 in., 148 pp., 13 fr.

Explains the principles of industrial thermometry, describes the various thermometers used and the scales employed, and discusses possible errors in the measurement of temperatures under industrial conditions, with the methods by which these errors may be eliminated or measured.

ÜBER DIE SPANNUNGSVERTEILUNG IN STANGENKÖPFEN. By Josef Mathar. (Forschungsarbeiten auf dem gebiete des Ingenieurwesens, heft 306.) V.D.I. Verlag, Berlin, 1928. Paper, 9 × 12 in., 23 pp., illus., diagrams 3.75 r.m.

In order to determine the accuracy of the formulas in use for determining the dimensions of the heads of piston rods and connecting rods, Dr. Mathar has carried out a series of laboratory tests to learn the distribution of the stresses. This report describes his work in detail. He shows that actual results vary widely from those calculated by some formulas.

A Correction

IN THE short biographical sketch of Charles P. Tolman which appeared on the Contributors' Page of the August issue (facing page 589), it should have been stated that Mr. Tolman served as chief engineer and chairman of the manufacturing committee of the National Lead Co. from 1907 to 1923, and that since 1923 he has been engaged in general consulting practice in New York City.

Form for Ordering Advance Copies of 1928 Annual Meeting Papers

NOTE: The Papers listed on page 900, to be presented at the A.S.M.E. Annual Meeting, December 3-7, 1928, will be available in pamphlet form and may be secured without cost by any member of the Society.

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A.S.M.E. Annual Meeting Program

New York, December 3 to 7, 1928

Monday, December 3

Morning: 9:30 A.M.
Council Meeting
Conference of Local Sections' Delegates

Afternoon: 1:00 P.M
Luncheon of Council and Local Sections Delegates.

2:00 P.M.
Conference of Local Sections' Delegates

2:30 P.M.
Council Meeting.

Monday Afternoon, December 3, 2:00 P.M.

Machine-Shop Practice (I)

Principles of Jig and Fixture Practice, Jos. W. Roe.

Applied Mechanics (I)

Deflection of a Round-Ended Strut Subjected to a Constant Moment or a Transverse Force at the Middle, Jas. E. Boyd.
Stress Distribution in Rotating Disks of Ductile Material After the Yield Point Is Reached, A. Nadai and L. H. Donnell.

Hydraulic

Flow in Pipes, M. D. Aisentein (by title).
Dredge Pump Pressures and Thrust Loads, Jas. H. Polhemus and Jas. Healy.
Researches on Small Rotary Pumps, Fritz Aschner and Herr Mattheus.

Monday Evening, December 3

Business Meeting, 8:00 P.M.

8:30 P.M., Open House

Tuesday Morning, December 4, 9:30 A.M.

Machine Shop Practice (II)

Symposium on Methods of Motor Application and Control:
Methods of Motor Application and Controls on Lathes, Chas. L. Cameron.
Motors for Planer Service, Forrest E. Cardullo.
Motor Drives for Precision Grinding, R. E. W. Harrison.
Application of Motors to Special Drilling and Tapping Machinery, J. H. Mansfield.

Industrial Power

Effect of Alloying Elements Upon the Stability of Steel at Elevated Temperatures, A. E. White and C. L. Clark.
Balancing Heat and Power in Industrial Plants, Robt. V. Kleinschmidt.

Hydraulic (II)

Some Interesting European Hydraulic-Turbine Research, Blake R. VanLeer.
New Aspects of Maximum Pressure Rise in Close Conduits, S. Logan Kerr.
Progress Report of Hydraulic Division.

Applied Mechanics (II)

Graphical Methods for Least-Square Problems, E. O. Waters.
An Investigation of Abrasion in Carbon Steels, M. Suzuki.

Tuesday Afternoon, December 4, 2:00 P.M.

Machine Shop Practice (III)

Finishes in the Machine Shop:
Mechanical Applications of Chromium Plating, W. Blum.
Carboloy and Tungsten Carbide Tools, Samuel L. Hoyt.

Education and Training for the Industries of Non-College Type

Preliminary Findings of a Study of Intensive Types of Technical Education, Robt. H. Spahr.

Materials Handling (I)

Plant Handling:
Material-Handling Problems in the Public Utility, John C. Somers.
Progress Report of Materials Handling Division.

Power Test Codes Public Hearing

Water-Cooling Equipment.

Tuesday Evening, December 4, 8:30 P.M.

Presidential Reception and Dance.

Wednesday Morning, December 5, 9:30 A.M.

Fuels

The Function of the A.S.M.E. in Smoke-Abatement Activities.
Progress Report of the Fuels Division.

Oil and Gas Power

Analysis of Oil-Engine Performance With a View to Rating, Otto Nonnenbruch.
Progress Report of Oil and Gas Power Division.

Management (I) (Jointly with A.M.A.)

A Basis for Evaluating Manufacturing Operation, L. P. Alford and J. E. Hannum.

Railroad (I)

Refrigeration in Railroad Freight Cars, J. W. Martin, Jr.
Characteristics of Injectors With Special Reference to Their Utility as Locomotive Feedwater Heaters, R. M. Ostermann.

Wednesday Afternoon, December 5, 2:00 P.M.

Illumination (Jointly with Illuminating Engineering Society)

Designing Buildings for Daylight, H. H. HIGBIE and W. C. RANDALL.
Artificial Lighting Provision in Building Design and Process Layout, WARD HARRISON.
Light as a Factor in Production, C. C. MONROE and H. A. COOK.

Railroad (II)

The Schmidt High-Pressure Locomotive of the German State Railway Company, R. P. WAGNER.
The Balancing and Dynamic Rail Pressure of Locomotives, R. EKSERGIAN.

Steam Tables Research

Reports.

Student Branch Conference

Ladies' Annual Tea Dance—3:00 p m.

Wednesday Evening, December 5, 6:30 P.M.

Annual Dinner, Hotel Astor.

Thursday Morning, December 6, 9:30 A.M.

Central-Station Power

Design of Steam Piping to Care for Expansion, W. H. SHIPMAN (by title).
Influence of Coal Type on Radiation in Boiler Furnaces, W. J. WOHLENBERG and R. L. ANTHONY.
Methods of Carrying Peak Loads, A. G. CHRISTIE.

Management (II) (Jointly with A.M.A.)

The Executive Function in Industry, ROBERT T. KENT.
Management Engineering in the Smaller Plant, J. E. DYKSTRA.
Outstanding Economic and Technical Factors Involved in Engineering of New Manufacturing Equipment, J. R. SHEA.

Aeronautics

Commercial Airplane Design, G. W. BELLANCA.
Relation Between Commercial Airplane Design and Commercial Uses of Airplanes, T. P. WRIGHT.

Lubrication

Journal Running Positions, H. A. S. HOWARTH.
Friction of Journal Bearings as Influenced by Clearance and Length, S. A. and T. R. MCKEE.
Cooling and Lubrication of Cutting Tools, Report of Sub-Committee on Cutting Fluids of the Special Committee on Cutting Metals.

Thursday Afternoon, December 6, 2:00 P.M.

Boiler Feedwater Studies

Progress Report of Executive Committee on Boiler-Feedwater Studies.
Progress Reports on:
Zeolite Softeners Internal Treatment, Priming and Foaming, Sub-Committee No. 3, C. W. FOULK.
Municipal Water Supplies and the Effect of Trade Wastes in Relation to the Use of Water in Power-Plant Practice, Sub-Committee No. 7, BERNARD SIEMS.
Standard Methods of Water Analysis, Sub-Committee No. 8, H. FARMER.
Bibliography of Boiler-Feedwater Studies, Sub-Committee No. 9, GEO. A. STETSON.

Fluid Meters

Flow Measurement, JOHN L. HODGSON.
Orifice Steam-Meter Coefficients, R. W. ANGUS.
Reports of Sub-Committees:
(1) Draft of New Material on Influence of Installation, Constituting Part II of the Report.
(2) Draft of New Material on Description of Flow Meters and Water Meters, Part III of the Report.
(3) Draft of Revision of Material on Pitot Tubes in Part I.
(4) Draft of Additional Material for Part I on Pulsating Flow.
(5) Draft of Additional Material on High-Velocity Measurements for Part I.
(6) General Revision of Part I.
(7) Additional Material for Part I on Dimensional Analysis.

Materials Handling (II)

Skid Handling of Interplant Shipment:
New Developments in Materials Handling, R. L. LOCKWOOD.
View point of Railroads, J. V. MILLER.
The Use of Skids for Water Shipments, H. E. STOCKER.
Viewpoint of Great Lakes Transportation Companies, G. B. WRIGHT.
Economic Aspects of the Shipment of Material on Skid Platforms, C. B. CROCKETT.
Viewpoint of Maker of Lift Trucks and Skids, F. J. SHEPARD, JR.

Symposium on Mechanical Springs

Stresses in Heavy, Closely Coiled Helical Springs, A. M. WAHL.
Fatigue and Fatigue Corrosion of Spring Materials, D. J. MCADAM.
Springs Used in Telephone Equipment, J. R. TOWNSEND.
Progress Report of the Research Special Committee on Mechanical Springs.

Thursday Evening, December 6

College Reunions.

Friday Morning, December 7, 9:30 A.M.

Iron and Steel

Heavy-Duty Anti-Friction Bearings, S. D. KOON.
Progress Report of Iron and Steel Division.

Printing Industries

Symposium on Paper and Ink as the Raw Products of Manufacture, and the Conditions That Affect Them:
Paper, OTTO W. FUHRMANN.
Ink, JULIUS FRANK.
Heat-Drying Equipment for Printing Presses, CHAS. H. COCHRANE
Grammer Process for Prevention of Offset, J. S. PECKER and H. C. COLE.
Air Conditioning in the Printing and Lithographic Industries, W. H. CARRIER and R. T. WILLIAMS.
Static Electricity, W. C. GLASS.

Wood Industries

Ball Bearings as Applied to Woodworking Machinery, H. E. BRUNNER.
Lubrication of Ball-Bearing Woodworking Spindles, HARRY R. REYNOLDS.
The Application of Universal Chucks to Woodworking Machinery, E. A. ENGLUND.
Report of Special Research Committee on Saws and Knives, CARLE M. BIGELOW, Chairman.

Joint Session with A.S.R.E.

Silica Gel, GEO. E. HULSE.

Synopses of A.S.M.E. Annual Meeting Papers

THESE papers, abstracts of which are being published on this and the following pages, are being printed in pamphlet form for the 1928 A.S.M.E. Annual Meeting. They may be secured by filling out the blank on page 884 of this issue.

AERONAUTICS

Development of the Commercial Airplane

By G. M. BELLANCA

President and Chief Engineer, Bellanca Aircraft Corp., Newcastle, Del.

THE author shows first how the development of commercial aviation has been affected by the uncertainty which has prevailed in aeronautical circles on account of the problems presented by the monoplane and the biplane, the method of cooling the engine and the desirability of single- and multiple-engine planes. In addition to the problems, the influence of military aviation has been a factor. Since 1926, however, commercial airplane design in this country became a distinctive project.

The commercial machine has been designed with the purpose of being economical and practical; and hence of maximum efficiency, comfort, and safety.

The author next discusses single- and multiple-engine planes; and follows with a consideration of pay load.

The last part of the paper brings out the essential part played by science and research in the design of airplanes and mentions some of the advances which are being made and some promising fields of experimentation.

Relation Between Commercial Airplane Design and Commercial Uses of Airplanes

By T. P. WRIGHT

Chief Engineer, Airplane Division, Curtiss Aeroplane & Motor Co., Inc., Garden City, L. I., N. Y.

THE object of the paper is to present the airplane designer's problems with an indication of the trend of design which it is felt possible may take place. The topics discussed are Fundamental Requirements; Design Elements, Commercial Uses of Airplanes, and Airplane Designs.

Under Fundamental Requirements the author discusses (1) singleness of function in airplane design, and (2) safety and reliability in aviation.

He advances the opinion that accidents brought about by causes not directly attributable to design deficiencies will steadily decrease as more readily controllable airplanes are produced and a better schools for instructing pilots are instituted; and as radio-distributed weather reports become more generally used in airplanes. Such accidents will become of the same order of importance as obtain in other fields of transportation. A similar condition will occur in accidents brought about by causes directly controllable in design, with the exception of power-plant failures. The increasing importance of this cause of accident will lead to a very general adoption of multi-engined ships in most fields of aeronautical activity; this on account of the fundamental importance of safety and reliability.

Under Economy of Air Transportation, stress is laid on the necessity for any commercial enterprise to pay its own way.

Under Design Elements the principal ones which the engineer must take into account are discussed, with note taken of the relative importance of each. Here again particular emphasis is placed on need for power-plant reliability, and figures are given to show the relative merit of airplanes equipped with different numbers of power units, from this standpoint.

Under Commercial Uses of Airplanes is given a brief discussion of the main uses for airplanes now foreseen, such as passenger transport, goods transport, training, air service, and sport and club flying.

Under Airplane Designs each type of airplane, as classified by its use, is discussed from the standpoint of design elements, in an attempt to establish a reasonable trend in design that may be expected.

APPLIED MECHANICS

Deflection of a Round-Ended Strut Subjected To a Constant Moment or a Transverse Force at the Middle

By JAMES E. BOYD

Department of Mechanics, The Ohio State University, Columbus, Ohio. Mem. A.S.M.E.

THIS paper gives an account of the experimental determination of the deflection of a round-ended strut subjected to a transverse force at the middle. The theoretical equations are derived and the deflections calculated from these equations are shown to agree with the experimental results. Since the design of the apparatus used in the tests was such that the transverse reactions were applied at a small distance beyond the ends of the strut, instead of exactly at the ends as would be assumed under ideal conditions, the bending moment caused by the transverse force was made up of a constant moment throughout the length of the strut in addition to the moment as a beam supported at the ends and loaded at the middle. For this reason the theoretical deflection includes one term for a moment which increases uniformly from each end to the middle, and a second term for a moment which is constant.

For the convenience of the practicing engineer, a formula is derived for each of these two moment conditions which gives the ratio of the additional deflection of the loaded strut when this moment is applied to its deflection as a beam in terms of the ratio of the longitudinal load to Euler's critical load. Tables are calculated and curves plotted which give the relation of these ratios with sufficient accuracy for practical computations.

Journal Running Positions

By H. A. S. HOWARTH

Kingsbury Machine Works, Philadelphia, Pa. Mem. A.S.M.E.

THE question of the stability of the running position of the journal upon its film presents itself to the author in the form of these questions: (1) Can the journal run with its center above the center of the bearing, that is, with its center above

a horizontal line through the center of the bearing, assuming the direction of the load is such that the journal presses vertically downward against the bearing? (2) Is there more than one stable running position for the journal for any one combination of load, speed, viscosity, and running clearance? and (3) Along what path does the axis of a journal rise from rest to its running position as its speed increases?

The present paper indicates that the journal lift, under adverse conditions, may be much greater than generally expected. This may result in rubbing against the cap. The design of the bearing cap therefore becomes important. The methods of providing and removing the lubricant are dependent upon the cap design. The cap may be fixed in an offset position as to maintain a pressure film that will reduce the journal lift. Such a cap would be suitable for one direction of rotation. If made so as to adjust itself automatically it would be suitable for either direction of rotation.

The journal life will not be serious if the oil is not heavy for the load-speed-clearance combination employed. In other words, a bearing that is too lightly loaded for the oil-speed-clearance combination may give trouble by rubbing against the cap. Again, if the speed is too high for the oil-load-clearance combination, similar rubbing may take place.

An Investigation of Abrasion in Carbon Steels

BY MASUHIRO SUZUKI

University of Illinois, Urbana, Ill.

THE author has extensively measured the relative abrasion in six hypoeutectoid carbon steels having different carbon contents and different structures by keeping the coefficient of friction constant, with an apparatus devised by him, and found two important laws for the relative abrasions of different steels. Thus,

$$W_{nm} = K\frac{W_{Nm}}{W_{Nn}} \quad \text{and,} \quad K = a\mu^2$$

where W_{Nm} = standard specific abrasion of a substance, m, with respect to a standard substance, N

W_{Nn} = standard specific abrasion of a substance, n, with respect to a standard substance, N

W_{nm} = relative specific abrasion between two substances m and n

μ = coefficient of friction

a = a constant, which remains invariable for a series of substances having similar properties, but varies when their properties differ considerably from each other. Thus, a is constant for a series of hypoeutectoid carbon steels subjected to the same heat treatments, or a series of solid solutions of binary alloys, etc., the coefficient of friction being kept constant.

By this formula, the amount of the relative abrasion between any two substances can be calculated, if their standard abrasions be known.

Fatigue and Fatigue Corrosion of Spring Materials

BY D. J. MCADAM, JR.

Engineering Experiment Station, Annapolis, Md.

FOR spring steels the ratio of the endurance limit in tension-compression, or repeated bend, to the tensile strength is from 0.4 to 0.5. The ratio of the torsional endurance limit to the tensile strength is from about 0.2 to 0.3. The torsional endurance range is about twice the torsional endurance limit and is practically constant for any position within the elastic range. It seems possible, also, that in tension-compression, or repeated bend, the endurance range is practically constant within the primitive elastic range. Further investigation of this subject is needed.

Monel metal and other nickel-copper alloys can be obtained, by cold working, with a tension-compression endurance limit of more than 50,000 lb. per sq. in. and a torsional endurance limit of about 35,000 lb. per sq. in. For copper-tin alloys the 5 per cent alloy, known as phosphor bronze, can be obtained with tension-compression endurance limit of about 27,000 lb. per sq. in. in the form of 1-in. round bars. In the form of smaller rod or wire, the endurance limit may be some what higher. Cold working, however, does not raise the endurance limit of this material in proportion to the increase in tensile strength. Nothing is known as to the effect on the endurance range of varying the ratio between the superior and inferior extremes of the range. This subject needs investigation.

The above-mentioned endurance limits are obtained with smooth specimens. The fatigue limit is greatly influenced by surface defects. Even shallow defects, if sufficiently sharp, may practically neutralize the effect of high strength on the fatigue limit.

Spring steels subjected to a range of stress while in contact with fresh water, fail at a stress range only one-fourth to one-ninth the ordinary endurance limit. In contact with salt water the endurance range is even smaller. Under such conditions the advantage of high strength due to composition or heat treatment is lost. The corrosion-fatigue limit depends more on electrochemical than on physical properties.

The corrosion fatigue limit of corrosion-resistant steels is about twice that of ordinary steels. Corrosion-resistant steels are available with elastic limit high enough to be suitable for spring material. Electroplating ordinary steels with cadmium and probably with other metals more than doubles the corrosion fatigue limit.

Nickel-copper and copper-tin alloys are subject to corrosion fatigue, but are not appreciably pitted at stress ranges below the corrosion fatigue limit. Under corrosion fatigue the advantage of high physical properties is neutralized.

The importance of protecting spring material against corrosion, especially when under a stress range, can hardly be overemphasized.

Friction of Journal Bearings as Influenced by Clearance and Length

BY S. A. MCKEE AND T. R. MCKEE

Respectively Assistant Mechanical Engineer and Research Associate, U. S. Bureau of Standards, Washington, D. C.

THIS paper describes an investigation at the Bureau of Standards, the object of which was to determine the effects upon the frictional resistance of small-bore full-journal bearings of changes in the length-diameter and clearance-diameter ratios.

A journal-bearing friction machine provided a method for measuring the frictional resistance when operating under different conditions of load on the bearing, speed of the journal, and viscosity of the lubricant. By a suitable correlation of these factors a measure of the effects of changes of clearance and length with bearings of the same diameter was obtained.

The results indicate that changes in the length-diameter ratio as well as in the clearance-diameter ratio have marked effects upon the frictional characteristics of journal bearings in normal

operation. Suitable corrections to a theoretical equation for journal friction are derived from these experiments for bearings of all normal clearances and lengths.

In conclusion, the author indicates further steps to be taken toward a more complete understanding of journal-bearing performance.

Stress Distribution in Rotating Disks of Ductile Material After the Yield Point Is Reached

BY A. NADAI AND L. H. DONNELL

Respectively Professor at the University of Göttingen, Germany, and Assistant Professor, University of Michigan, Ann Arbor, Mich.

THIS paper covers a study of the distribution of stress in a rotating disk of ductile material (of uniform thickness, with and without a central hole) after the yield point has been passed. Curves are computed showing the growth of the "plastic" region at different speeds, until the whole disk has become plastic. General methods are developed, and applied to examples for finding the complete distribution of stresses and strains in such disks.

While the conditions assumed are seldom exactly realized, the results should throw light on many practical problems as well as form a starting point for a more complete investigation of more complex problems of plastic flow in ductile materials. This work has been carried out at the Research Department of the Westinghouse Elec. & Mfg. Co. at East Pittsburgh.

Stresses in Heavy, Closely Coiled Helical Springs Axially Loaded

BY A. M. WAHL

Research Department, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

IN THIS paper more exact formulas are derived for computing stress in heavy, closely coiled helical springs of the type used frequently in railway work. These formulas indicate that the maximum stress in such springs may, in many practical cases, be from 40 to 70 per cent greater than the stress computed by the use of ordinary helical-spring formulas. The new formulas are verified by strain measurements, using special extensometers, on semi-coils of actual springs, loaded so as to simulate the axial loading of a complete spring, and on complete springs loaded in compression. The work indicates that the frequent failures of this type of spring in service may at least in part be due to the existence of higher stresses than thought possible on the basis of ordinary spring formulas.

Graphical Methods for Least-Square Problems

BY E. O. WATERS

Assistant Professor, Mechanical Engineering, Yale University, New Haven, Conn. Assoc-Mem. A.S.M.E.

GRAPHS of experimental data are generally drawn by cut-and-try methods. Since it is impossible, in practically all cases, to make a straight line or a smooth curve pass through the plotted points, the test engineer sketches in a line that comes fairly close to the points, and "looks right;" or else he segregates the points into three or four groups, finds the average position of each group, and draws a curve through these average points.

The "best" curve in any case can be computed by the method of least squares, but the process is laborious, and introduces errors commensurate with those of the original observations unless the calculations are worked out longhand or with a computing machine. Apparently, therefore, a quick, accurate method for performing these computations graphically should be of interest to all who have the task of working up experimental data.

The present paper describes such a method. To obtain a straight-line graph, three simple, direct steps are necessary. By means of certain additional constructions, or by using logarithmic cross-section paper, the method may be extended to curves of almost any desired form. In the case of data having cyclic variations, such as kilowatt output of central stations, meteorologic observations, etc., the "best" periodic curve may be derived graphically by a slightly different method. In any event, guesswork is replaced by reliance upon the established propositions of the theory of probability.

Progress Report No. 4—A.S.M.E. Special Research Committee on Mechanical Springs

THE A.S.M.E. Special Research Committee on Mechanical Springs presents this paper as its Progress Report No. 4 covering the experimental results obtained by Anthony Hoadley, Research Associate of the Committee, at Union College, Schenectady, N. Y. In general the purpose of this investigation is to determine more accurately certain spring constants upon which the construction of the proposed Code of Design for Mechanical Springs depends. More specifically the investigation concerns the behavior of a $^1/_2 \times ^1/_8$-in. spring-steel bar under uniform flexural stresses when accompanied by the relatively large deflections which are characteristic of spring action. Although a considerable amount of work remains to be accomplished before completing the solution of this problem, certain conclusions seem to be warranted at this time.

Results indicate that hysteresis losses in a spring steel such as was tested were approximately one-fourth of those obtained in an Armco iron listed by G. H. Kuelegan of the U. S. Bureau of Standards. From the experimental work there seems very definite evidence that for a given total range of stress, the magnitude of the hysteresis increases rapidly as the minimum stress in the range increases in value. An unexpected result of the investigation is that the hysteresis in tension was found to be far less in proportion to that in bending than was expected. Barring instrumental defects, there seems to be no apparent reason for this phenomenon, hence it may develop that some important fact has been discovered.

FUELS AND STEAM POWER

Flow Measurement

BY JOHN L. HODGSON

Eggington House N.W., Leighton Buzzard, Bedfordshire, England

This paper has been prepared at the request of the A.S.M.E. Special Research Committee on Fluid Meters for presentation at its open session during the coming Annual Meeting. The author is an international authority on the orifice measurement of fluids. He has summarized in this paper all the work which is now of importance that has been accomplished by him during the past twenty years, and includes abstracts from the many articles and papers which he published on the subject in England. The paper, however, does not enter into detail with respect to the

work which he has done in designing actual flow-measuring devices, but deals with fundamental considerations upon which all differential flow meters must be based.

Orifice-Steam-Meter Coefficients

By ROBERT W. ANGUS

Professor of Mechanical Engineering, University of Toronto, Toronto, Ont. Mem. A.S.M.E.

THE value of the thin-plate orifice as a fluid meter has been established beyond all question, and many very successful commercial applications of it are on the market. There are, however, not many tables of actual orifice coefficients, these being apparently retained by the manufacturers. This paper gives a table of orifice coefficients for steam meters, based on results obtained in tests made in the steam laboratory of the mechanical engineering department of Toronto University.

Peak-Load Problems in Steam Power Stations

By A. G. CHRISTIE

Professor of Mechanical Engineering, Johns Hopkins University, Baltimore, Md. Mem. A.S.M.E.

THIS paper deals with the problem of the annual peak load in steam power plants. The use of the load-duration curve for the purpose of studying annual peak loads is analyzed and the conclusions drawn that (1) plant intended for annual-peak-load service should only be installed at the lowest possible first cost, and (2) that economy of peak-load equipment can be sacrificed to secure low initial cost.

Various schemes that have been proposed to provide equipment for carrying the annual peak loads are analyzed. The three plans that appear most promising are those involving the use of steam accumulators, of peak-load units, and of present plant after new base-load equipment has been added.

In order to indicate the possible annual savings through the application of these three methods, the author assumes an electric system with a maximum annual peak load of 200,000 kw., together with certain data for annual load factors of 65, 45, and 25 per cent on this system. With certain assumed plant costs, fuel costs, and operating performances, an analysis is made of the annual operating costs of the various methods, and the possible annual savings that may be effected through the use of steam-accumulator plant or peak-load units are shown in the form of a series of curves. These savings in some cases may be of a large order.

Balancing Heat and Power in Industrial Plants

By ROBERT V. KLEINSCHMIDT

Research Engineer, A. D. Little, Inc., Cambridge, Mass. Jun. A.S.M.E.

THE purpose of this paper is to indicate the importance of various factors in increasing the amount of by-product power that can be generated in industrial plants using process heat. It is shown that there are opportunities for economies in increased boiler pressures, higher superheats, and particularly by reducing the back pressure on turbines and engines to the lowest possible point. Utilization of waste heat from heating furnace gases offers an opportunity for additional power generation in mixed-pressure turbines or in low-pressure condensing turbines. It is shown that hot air can be most economically used by returning it to the boiler furnace, and heating air for process work with exhaust steam.

Two curves are presented which give the results of a detailed analysis of the problem of water heating, one showing the advantages of two-stage water heating as compared with heating by exhaust steam only, and the other giving the best condenser vacuum for various initial and final temperatures of water in a two-stage process. Attention is called to the importance of an adequate study both of the heat and power requirements of the process, and of possible alterations of process as a basis for the improvement of the heat-power balance.

Design of Steam Piping to Care for Expansion

By W. H. SHIPMAN

The Atmospheric Nitrogen Corporation, Syracuse, N. Y.

THIS paper endeavors (1) to arrive at the fundamental principles of design, (2) to present a complete mathematical theory of piping subjected to expansion, and (3) to reduce the very complicated results to a simple, usable basis.

The mathematical analysis of expansion stresses and reactions is presented for discussion as the basis of a proposed code of practice for the design of steam piping. The mathematical analysis is verified by experimental work, part of which has been previously published, and part of which is original. Further check by experiment is desirable, and the cooperation of other engineers is requested in building up an absolutely dependable body of data upon which a code of practice may be based.

Effect of Alloying Elements Upon the Stability of Steel at Elevated Temperatures

By A. E. WHITE AND C. L. CLARK

Respectively Professor of Mechanical Engineering and Director of Department of Engineering Research, University of Michigan, Ann Arbor, Mich. Mem. A.S.M.E.; and Holder of Detroit Edison Fellowship in Metallurgy at the University of Michigan

ALLOY steels during the past few years have made rapid strides in an entirely new field, namely, in the construction of metallic parts which are to withstand stresses at elevated temperatures. Due, however, to the large number of alloy steels available, there is often considerable confusion as to just what alloy steel is best suited for the problem at hand. It was for the purpose of furnishing information regarding the effect of various alloying elements upon the steels to which they were added that the work reported in this paper was undertaken. The paper endeavors to throw additional light on and furnish further data with respect to the properties of metals at elevated temperatures. It has done this by (1) advancing a theory or hypothesis accounting for the stability of the various types of steels at elevated temperatures, and (2) by giving specific data on various types of alloy steels showing (*a*) the effect of elevated temperatures on various types of steels when in an annealed or normalized state, and (*b*) the effect of heat treatments which would presumably bring out the best possible proportional limit values on various types of steels when tested at a temperature of 1000 deg. fahr. (538 deg. cent.)

Influence of Coal Type on Radiation in Boiler Furnaces

By W. J. WOHLENBERG AND R. L. ANTHONY

Professor of Mechanical Engineering, Sheffield Scientific School, Yale University, New Haven, Conn., and Mem. A.S.M.E., and Laboratory Assistant, Yale University, Jun. A.S.M.E.

THIS paper includes the results of an application of the methods and data presented in a previous A.S.M.E. paper "The Influence of Radiation in Coal-Fired Furnaces on Boiler-

Surface Requirements, and a Simplified Method for Its Calculation," by W. J. Wohlenberg and E. L. Lindseth, to pulverized coal for a number of coals of widely varying composition. After an evaluation of radiation quantities for each of these coals, further investigation was made for the purpose of ascertaining what quantitatively measurable property of coals might be most significant in differentiating one from another during combustion with respect to the quantity of energy which is transferred as heat to the walls of a boiler furnace. It was found, of the properties investigated, that the calorific value serves as the most consistent and useful indicator of the radiation powers of a coal as burned in the pulverized form in boiler furnaces.

Progress Report of the Boiler-Feedwater Studies Committee

FIVE sub-committees of the Joint Research Committee on Boiler-Feedwater Studies are to present progress reports of their past year's work at the Annual Meeting.

Much time has been spent by the Executive Committee during the past year toward raising the fund for the proposed research program. No active work is planned on this program until the entire fund of $300,000 has been pledged for the five-year study.

The Committee directs attention again this year to the great losses occurring in the operation of steam stations resulting from contaminated water supplies due to stream pollution by trade wastes.

The Committee's activities indicate that duplication of effort is being eliminated. This has been demonstrated by the work of Sub-Committee No. 8, which has proposed tentative standard methods of analyses applicable to power-plant use. Some of these methods are now being tested in a number of central-station laboratories.

A program to report on the present state of knowledge on foaming and priming has been formulated.

Throughout the year technical papers have been presented before the various groups interested in these problems. These papers have been submitted as contributions to the work of the committees. Some 250 abstracts of the technical literature of the world pertaining to Boiler-Feedwater Treatment and allied problems have been supplied the Committee by the A.C.S. Chemical Abstracts, and the A.S.M.E. Engineering Index Service.

Active interest has been created in the work of the Committee among engineers in this country and abroad.

GAS AND OIL POWER

Analysis of Oil Engine Performance With a View to Rating

By OTTO NONNENBRUCH

De La Vergne Machine Company, New York, N. Y. Mem. A.S.M.E.

IN THIS paper the author analyzes a number of reliable tests on Diesel engines by disinterested authorities to determine fuel consumption per brake hp-hr. and per indicated hp-hr. He finds that the friction load in all cases is constant over the whole load range, and that the fuel consumption per indicated hp-hr. at low mean indicated pressure is practically the same for all types of engines. This and the regularity with which the indicated fuel consumption increases with increasing mean indicated pressure, make it possible, to derive the indicated fuel consumption and the indicated hp. of an engine from brake fuel-consumption tests without indicator cards. The procedure is illustrated by examples. The general rating of Diesel engines at a standard indicated fuel consumption is suggested.

HYDRAULIC

Flow of Pipes

By MICHAEL D. AISENSTEIN

Hydraulic Engineer, Byron Jackson Pump Manufacturing Company, Berkeley, Calif. Jun. A.S.M.E.

THE purpose of this paper is to present general formulas for the frictional resistance in straight circular pipes, based on experiments of different authorities, and to show their application to the solution of different problems in connection with divided flow. The author also derives an equation for accelerated streamline flow.

Tests on Small Rotary Pumps

By F. ASCHER and HERR MATTHEUS

Berlin, Germany

GEAR pumps and other small rotary pumps are used for pumping lubricating oil, cooling water, and other liquids to all kinds of machines, and especially to machine tools and steam and internal-combustion engines. Published information on the behavior of these pumps under a variety of pressures, speeds, and oil viscosities is very scarce, even though forced lubrication by means of such pumps is the basis of modern engine construction. The Mechanical Laboratory of the Technical University of Breslau has attempted to remedy this lack of data by performance and efficiency tests under various working conditions on rotary piston pumps as used on the Hispano-Suiza engine, and on gear pumps for machine tools and automobile engines as constructed by Ludwig Loewe, Berlin and Breuer, Hoechst a/M.

Dredge-Pump Pressures and Thrust Loads

By JAMES POLHEMUS and JAMES HEALY

Respectively General Manager and Chief Engineer,[1] and Master Mechanic, The Port of Portland, Oregon. ([1] Mem. A.S.M.E.)

THE Port of Portland engineering staff, desiring to determine the actual thrust loads and pressures acting on the impeller of a dredge pump, carried on some very interesting tests during the early part of this year, which should be of interest to members of the Society.

Pressure gages were installed at controlling points in both the front and back heads of the 2700-s.hp. 30-in. pump of the dredge *Clackamas*, and a series of tests were run to determine the effect of varying lengths of pipe line, impeller clearances, and impellers with and without relief holes in the back shroud. The results of the tests showed clearly—

1 That relief holes in the back of the impeller materially reduced the thrust load and did not reduce the efficiency of the pump to any noticeable degree.

2 That renewable clearance rings and small vanes on the outside of the impeller shrouds are necessary to maintain close clearances and control the thrust loads.

3 That while large clearances produce low thrusts, close clearances do not create a prohibitive thrust and are necessary to maintain a high pump efficiency.

4 That the pressures on the front and back shrouds are not

the same and are considerably less than the pump discharge pressure.

5 That the whirlpool pressures are not as high as the discharge pressure of the pump, and that the pressures in the lower half of the pump casing are somewhat greater than those in the upper half.

6 That it is not necessary to carry the same pressure on the water service to the pump-shaft seal as the discharge pressure of the dredge pump.

7 That as might be expected, the thrust load increased with the total head.

8 That the thrust load is greater for any given condition when pumping material rather than pumping water as a medium.

9 That the thrust loads are less for any given heads with the smaller high-speed pump impeller as compared with larger low-speed impellers.

New Aspects of Maximum Pressure Rise in Closed Conduits

By S. LOGAN KERR

Assistant Chief Engineer, I. P. Morris Corp., Philadelphia, Pa. Assoc-Mem. A.S.M.E.

THIS paper discusses the various elements entering into the determination of the true maximum rise in pressure which may occur in closed conduits. It shows that, contrary to the usual belief, the maximum rise in pressure will not necessarily be produced when the full flow in a given conduit is cut off, but is a function of the initial flow from which the deceleration starts. The necessity of establishing the relation between the average conduit velocity and the rate of gate travel for various proportional strokes is cited.

Comparison is made of the computations by several of the accepted methods based on the elastic-wave theory, and a translation of important studies made by M. Maurice Gariel in France is included. The application to practical cases is outlined and specific examples are worked out in detail.

A general summary of water-hammer computations is given, with several simple formulas for the rapid calculation of the critical conditions.

Some Interesting European Hydraulic-Turbine Research

By BLAKE R. VAN LEER

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THIS paper calls attention to the general European attitude toward hydraulic-turbine research; reviews the paper "Experimental Research in the Field of Water Power," by Dr. D. Thoma; mentions the hydraulic laboratories of Europe doing work in this field; gives briefly the European status on model to full-scale efficiency formulas, draft-tube research, and cavitation, and then discusses two distinctly European turbines, the Kaplan and the Banki. The author outlines the field of the Kaplan turbine, states its advantages and disadvantages, and lists some fifty-three Kaplan turbine installations now in operation.

The theory of the Banki turbine as developed by Professor Banki is given along with several design formulas. Its advantages and field of operation are also shown.

The author does not claim for these European methods and turbines a superiority over those of America, but presents them because they are different and with the hope that they will therefore give to hydraulic engineers suggestions for study and research which pave the road to engineering progress.

MACHINE-SHOP PRACTICE

Mechanical Applications of Chromium Plating

By W. BLUM

Chemist, Bureau of Standards, Washington, D. C.

CHROMIUM plating owes its application upon mechanical equipment primarily to its great hardness, as exhibited in its resistance to abrasion. The chief limitation in the use of chromium for such purposes is its extreme brittleness, which may cause it to crack and flake when deformed. The most successful mechanical uses of chromium are upon measuring instruments such as gages of all types, the service of which is often multiplied several fold. Upon forming and molding dies it is generally satisfactory and beneficial, especially if the conditions do not involve too severe impacts. Upon cutting tools it is of doubtful value, though in numerous applications it has proved successful. Upon moving parts of machinery there have been but few successful applications, but these indicate that with further study many such uses may be developed.

It is impossible to estimate even roughly the savings that have been or may be accomplished through the use of chromium on mechanical equipment. Chromium plating is not a panacea for wear. It has, however, solved many shop problems, reduced costs of operation, and improved the quality of the products.

Methods of Motor Application and Controls on Lathes

By CHAS. L. CAMERON

Monarch Machine Tool Co., Sidney, Ohio

IN THIS paper the author states some of the difficulties experienced in the application of a motor to a lathe due to the lack of standardization of essential points. He touches on the popularity of the multiple V-belt drive, and the economy of individually motor-driven lathes. Effective means of keeping down the original cost of installation, improved anti-friction bearings, and constant-speed alternating-current motors are also discussed. He concludes by stating that the development of an alternating-current, variable-speed, constant-horsepower motor having at least six or eight speed changes, with a motor of reasonable size and price, would revolutionize the design of lathe headstocks as well as of many other classes of machine tools.

Motors for Planer Service

By FORREST E. CARDULLO

Chief Engineer, The G. A. Gray Company, Cincinnati, Ohio. Mem. A.S.M.E.

REVERSING motors for planers are usually adjustable-speed shunt motors of special construction with a speed range of from 250 to 1000 r.p.m. Two- and three-speed induction motors of special design have been used, but are relatively unsatisfactory. Variable-voltage d.c. motors supplied with current from a special motor-generator set are of advantage when a large speed range is desired, say, from 150 to 1200 r.p.m. or more, but are relatively expensive unless only alternating current is available and only one planer is to be equipped.

The paper investigates the phenomena of reversal based on simplified assumptions, and makes calculations of the time lost in reversal for a 25-hp. reversing motor drive and a 15-hp. reversing belt drive. The method of taking an "indicator card" from a planer in order to study the phenomena of reversal is described.

Motor Drives for Precision Grinding Machines

BY R. E. W. HARRISON

Director, Cincinnati Grinders, Inc., Cincinnati, Ohio. Mem. A.S.M.E.

THE abandonment of overhead countershaft and lineshaft drives to machine tools in general has been marked during the last five years, and particularly in the case of precision grinding machines.

For many years the cumbersome countershafts and the multiplicity of belts which characterized the earlier-type grinding machines, imposed a handicap on production and added materially to the general unsightliness and lack of driving efficiency in the average machine shop. It was therefore only a matter of time before serious attention should be given to the elimination of countershafts, and a definite effort made to not only improve the appearance but to add to the power-transmission efficiency of the machines.

Particularly was this necessitated by the improvement made in the metal-removal capacity of grinding wheels, calling for the application of much more power to the point of contact between the grinding wheel and the work.

Many of the earlier grinding machines had almost as much bulk of machinery attached to the ceiling as to the floor, and although accidents from this source were rare, it was generally considered by both users and manufacturers that this condition of affairs was a reflection on the mechanical ingenuity of all parties involved.

As a typical example of the lines along which development has taken place, the author presents diagrams which show the stages through which various types of precision grinding machines have passed during the last few years.

Carboloy and Tungsten Carbide Tools

BY SAMUEL L. HOYT

General Electric Co., Schenectady, N. Y.

CONSIDERABLE interest has been shown in the past few years in the new tool materials which have tungsten carbide as a base. In this paper the author aims to present certain features of particular interest to the mechanical engineer. The name "Carboloy" has been adopted by the General Electric Co. as its trade name for materials of this type.

The most promising field for the use of tungsten carbide tools is in machining materials which are so abrasive that ordinary tools are speedily worn away or lose their cutting edge, but which do not exert great pressure on the tool. The author points out that the economic value of Carboloy is so great in many instances that it at once justifies its use. In some others this will not be so marked, and in still other cases its use will be less economical or not at all suitable. Among the latter applications may be mentioned finishing cuts on iron and steel, hogging cuts on steel, or, in general, cuts with heavy feeds and cuts which impose heavy pressures on the tool.

Heavy-Duty Anti-Friction Bearings

BY SIDNEY G. KOON

Associate-Editor, *The Iron Age*, New York, N. Y.

ADVANTAGES of ball or roller bearings on almost all types of operating mechanisms are stressed in this paper. There is not only the saving in power consumption, which frequently runs from 25 to as much as 60 per cent, but also collateral advantages of varying description. Frequently the bearings permit operations which without them would be exceedingly difficult or expensive.

Some of the limitations to the use of the bearings are taken up, particularly those dealing with space limitations on equipment of old design. The concurrent development of heavy-duty bearings for steel-rolling-mill work along with backed-up types of rolling mills is traced at some length. Many features of operating conditions found in steel mills are discussed in their relation to the use of bearings of this type. Lubrication and care of the bearings are also given consideration.

How much load the roller bearing will carry and how long it will carry that load satisfactorily are not yet known. The whole field of roller-bearing uses on a large scale is in process of development, and ideas have not yet crystallized on many features of the work. In the present state of development they operate successfully under many varying conditions, but it is essential that they be adapted particularly to the work which they are called upon to do. The fact that wear is practically negligible permits maintenance of constant operating conditions to a much longer period than with plain bearings, and makes a strong point in favor of the anti-friction type. It seems to be generally accepted that, in a great many cases, their greater initial expense is fully justified by the results to be expected from their use.

Principles of Jig and Fixture Practice

BY JOSEPH W. ROE

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JIGS and fixtures have been developed empirically, and principles of good practice have grown up in the toolrooms. While there is great diversity in fixtures, certain principles have come to be recognized as good practice. It is the purpose of the paper to bring these together.

The author stresses economic considerations, an aspect usually given inadequate attention, and about which little has been written. A set of simple and workable formulas are developed which relate estimated cost, number of pieces run per year, and profit, taking into account the length of run, saving in unit labor cost, overhead, frequency and cost of set-ups, interest, taxes, insurance, upkeep, depreciation, etc., and examples are given showing their application.

This is followed by a statement of general principles of the use of jigs and fixtures and of their design, covering such details as locating, clamping, bushings, latches, etc.

A bibliography is given covering the best books, technical papers, magazine articles, and data sheets dealing with jigs and figures, with a subject index covering the material available in them.

Cooling and Lubrication of Cutting Tools

Report of the Sub-Committee on Cutting Fluids of the A.S.M.E. Special Research Committee on Cutting of Metals

THIS report begins with a review of the many unsettled questions of cutting-fluid performance which have led to the formulation of a general program for research on that subject by the Society in cooperation with the Bureau of Standards and other organizations. Then follows a brief survey of current practice in the selection of cutting fluids for the respective operations and for the various materials to be cut, based upon information received from a number of the leading metal-cutting plants in the United States. Afterward there is given a brief outline of recent experimental work, which will be continued as rapidly as financial support is obtained. The report is concluded by

appendixes containing (1) a bibliography of cutting-fluids literature; and (2) a chart for tabulating current shop practice in the use of cutting fluids. The experimental program recommended by the sub-committee aims to determine quantitative relations connecting the cutting performance of the fluid in any given process such as finish turning of steel with the numerous variables on which it may depend, including not only such factors as speed and depth of cut but also the physical properties of the fluid, such as its specific heat and its oiliness.

Application of Motors to Special Drilling and Tapping Machinery

By J. H. MANSFIELD

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THIS paper deals with the application of motors and controls to single-purpose, multiple fixed-spindle, way-drilling, tapping, turning, boring, and facing machines, and the advantages of variable and multi-speed motors.

MANAGEMENT

A Basis for Evaluating Manufacturing Operation

By L. P. ALFORD and J. E. HANNUM

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THIS paper is divided into two parts. The first is a presentation and discussion of a basis and methods for evaluating certain factors in the operation of manufacturing establishments. The second is a consideration and interpretation of these factors as they are revealed by the analysis, on the basis proposed, of a considerable volume of manufacturing records and statistics. The authors' purpose in undertaking this study was to develop an analytical method, but the significance of the factors of operation as discovered seems to warrant devoting the larger amount of space to them.

Management Engineering in the Smaller Industrial Plants

By J. E. DYKSTRA

Factory Manager, The Champion Company, Springfield, Ohio. Mem. A.S.M.E.

IN THIS paper the author sets forth some of the fundamental underlying principles that are of vital importance in installing a system of scientific management in the average industrial plant having 500 employees or less. He names and treats at length the three most important items: namely (1) Production Control, (2) Grouping of Equipment and Its Classification, together with the possibility of modern equipment, and (3) the item of Personnel or Man Power that is so essential to make successful operation possible.

Under production control he treats such items as Scheduling, Routing, Costing, Stores Control, and Purchasing, and shows how all these items form a definite system of production control.

Under the second item he points out the best methods of grouping of equipment for best results, and gives some reasons for and methods of classification to provide the needed flexibility to permit the system to function in case of breakdown or in case some machines should be overloaded.

Time study and the qualifications of a good time-study man are also treated at length, and considerable is said regarding the tool analysis for a given job, as well as the possibilities that are latent in an analysis of non-productive labor as well as productive labor. Means of determining the possibility of new equipment are described at some length and the author suggests that savings possible with new equipment can frequently be shown to best advantage in terms of wages saved rather than in the saving in cost per unit produced.

In the third item the author dwells strongly upon the possibility of leadership, and brings out the fact that increased effort cannot be expected from the average employe without increased compensation.

Artificial-Lighting Provision in Building Design and Process Layout

By WARD HARRISON

Director of Illuminating Engineering, National Lamp Works of General Electric Company, Nela Park, Cleveland, Ohio

SINCE daylight provides adequate illumination for only about one-half of the working area in a modern multi-story factory building, general artificial illumination is essential for effective use of the entire space for productive purposes. The procedure for the correct design of such a system is outlined in the paper.

It is wise to provide for additional capacity when wiring for a lighting system. The increased expense is slight compared with the cost of a complete new wiring job if conditions arise which require a higher standard of illumination intensity. Data are given which shows that it costs but 28 per cent more to wire for double wattage, while to change the wiring to care for this condition will at least double the original cost.

The design of lighting systems will vary from the usual procedure when position of workers, machinery, material, or fineness of the work introduces special conditions. In textile manufacturing certain parts of the machines need more light than others, and the location of the lighting units should be determined by the location of the machines rather than by the arrangements of bays. Where workers are all facing in one direction a unit is provided which allows no direct light to shine in the worker's eyes. In finishing automobile bodies the vertical sides of the bodies are supplied with a uniform high level of illumination from special projectors. In an inspection department where very fine details must be examined, there is installed a concentrating-type reflector over each position, giving a high intensity at the bench and at the same time supplying the general illumination for the room. This is contrasted with the old system of local lighting which resulted in a multitude of glaring bright spots among dark surroundings.

Designing Buildings for Daylight

By H. H. HIGBIE and W. C. RANDALL

Respectively Professor of Electrical Engineering, University of Michigan, Ann Arbor, Mich., and Chief Engineer, Detroit Steel Products Co., Detroit, Mich.

THE paper outlines methods by which the amount and distribution of daylight illumination that should be produced by any specific window arrangement in the interior of a building may be predicted. The method is based upon rigorous theoretical analysis and has been checked repeatedly by field tests upon full-size buildings as well as by laboratory tests upon models of buildings. Some results of the application of the method to analysis of the lighting effect of changes in the fenestration of

typical buildings, are discussed. A bibliography and a digest of the most significant literature of the subject are given, including important data on the effects of window glass, shades and blinds, mullions and columns, light-reflecting surfaces both within and without the building, sawtooth, monitor and other types of roof in single-story buildings, and light courts in multi-story buildings. Suggestions are made for facilitating the continued development of this important and neglected field of work, which should soon result in acquisition of an intelligent experience and technique comparable with that which characterizes modern artificial lighting.

The Executive Function in Industry

By R. T. Kent

Manager of Sales and Director of Engineering, Divine Brothers Co., Utica N. Y. Mem. A.S.M.E.

THIS paper is a plea for the more general adoption of budget control in manufacturing industry. It outlines the method of making up a budget, and the relations of the sales, production, purchasing, and financial functions, and their coordination through the budget. It also shows how the budget may be used to expose inefficiencies in the operation of an industry.

Light as a Factor in Production

By C. C. Monroe and H. A. Cook

Respectively in charge of Lighting Service Division, and Lighting Service Division, The Detroit Edison Co., Detroit, Mich.

LIGHT is an important factor in the successful operation of any industrial plant. Inadequate lighting, i.e., lighting of a low intensity with glare present and the illumination improperly distributed throughout the interior, will hinder the various industrial processes; while adequate lighting, i.e., sufficient intensity, glare eliminated, and a satisfactory distribution of light, will assist in the operation of industrial plants.

Adequate lighting will increase production, the average increase being 15 per cent at a cost of 2 per cent of the payroll; it will decrease industrial accidents, this reduction producing a saving in plant operation costs; it will reduce labor turnover and spoilage, again assisting in the production of materials at a low cost; and it will assist in the maintenance of the health of the employees, which tends to produce a greater organization efficiency.

These factors with their combined influences make it highly desirable that the lighting of a plant receives consideration similar to that of the machinery to be installed, because it can be stated without question that the efficient operation of an industrial plant is influenced to a certain extent by the character of the illumination used.

Development or Selection of New and Improved Manufacturing Equipment

By J. R. Shea

Supt. Manufacturing Development, Hawthorne Station, Western Electric Co., Chicago, Ill. Assoc-Mem. A.S.M.E.

IN THIS paper the author first points out the importance of the problem of selecting or developing new and improved manufacturing equipment suited for the economical production of a finished article of the desired quality, and then proceeds to discuss the basic principles underlying the solution of this problem. The subject is developed under three main headings: (1) The economic analysis, (2) the technical analysis, and (3) the practical application.

The economic analysis is essentially a summary of the various elements of cost involved in a proposed manufacturing plan, and the final choice of the equipment is based on this analysis. The author presents an economic analysis which is a composite of several of the recent developments of his company, stating that this analysis is the result of an intensive study of the technical phase of the question. He then proceeds to discuss the technical analysis, which comprises a study of the design of the product in all its stages, including the trend in its development and of the question of methods of processing these methods, the more important factors of which influence the choice of proper equipment. In the author's opinion, equipment should be selected on the basis of the facts developed by the analyses described, with the ultimate plan of the entire plant in mind to the end that each machine may function as a part of a single economic unit. He then mentions several important items relating to the selection of standard equipment, and concludes with a description of several special machines developed to meet the manufacturing needs of the Western Electric Company, and a discussion of the outstanding facts which may justify expenditures for such developments.

MATERIALS HANDLING

Economic Aspects of the Shipment of Material on Skid Platforms

By C. B. Crockett

The Society for Electrical Development, Inc., New York

THIS paper presents some of the economic aspects of the above method viewed purely from the standpoint of the shipper or receiver of the material. The method is described as regards equipment, its uses, and the relation to the manufacturing processes. A comparison is made between the total cost of physical distribution and the cost of freight transportation only, pointing out the small influence of the latter factor on the total cost. The field of savings is then discussed, including labor costs, speed of car loadings, the container or skid, and the damage to material, and illustrations of actual instances which have occurred in various industries are given.

The paper closes with the treatment of the possible growth of the system and the four main factors which may influence its more general adoption: (1) the breadth of application to different commodities, (2) the coordination of the system with methods of handling within the plant, (3) the attitude of the railroads and other carriers, and (4) the degree of interchangeability in the equipment.

New Developments in Materials Handling

By R. L. Lockwood

Division of Simplified Practice, Dept. of Commerce, Washington, D. C.

IN THE period of 1890 to 1910 a revolution was accomplished in methods of handling bulk goods. This period saw the greatest development in the power shovel, the huge unloading and loading machines for railroad cars and ships, the great bridge and gantry cranes, the continuous conveyor, and many other devices. During the early years of the twentieth-century engineers made rapid progress in developing new methods for handling materials of construction, and an equally intensive development went on in methods of handling goods in process in factories.

Up to the time of the World War little attention had been paid to handling finished goods. During the period in which the

skid and lift truck were extensively developed, a parallel development took place in connection with industrial tractors and trailers.

Materials-handling equipment of every kind can be counted upon to save its full cost within a definite period of time. Savings due to labor and time-saving equipment in many fields are sometimes partially offset by collateral losses in changed methods, inconvenience, or some other form of avoidable waste. Handling materials is almost in a class by itself in this respect in that savings made represent net gains shared by all elements in industry. A fundamental economic principle has been concisely expressed in a form which might well become a slogan for the materials-handling industry: "Handling materials adds cost, but adds no value."

What the Railroad Stores Division of the C.M.St.P. & P.R.R. Has Done in the Handling of Skid Shipments

By J. V. MILLER

Asst. Genl. Storekeeper, Chicago, Milwaukee, St. Paul and Pacific Railroad

TREMENDOUS quantities of stores are handled by every American Railroad. These stores are to a large extent received in a central storeroom and are then forwarded as needed to local storerooms in various centers. Under ordinary conditions this procedure involves considerable rehandling.

During the past few years the C. M. St. P. & P. Railroad has succeeded in cutting down this rehandling by storing many of its supplies on skid platforms. When shipments are made up to send out to the local centers the supplies are thus to a large extent picked up directly on the original platforms by means of lift trucks, moved into the railroad cars, transported to their destination and there unloaded by lift trucks. Three handlings are thereby eliminated.

The above program has been carried to a development whereby about 65 per cent of the former handling cost is now saved through the skid platform method of handling and shipping. The number of railroad cars tied up in shipping stores has likewise been reduced until now 33 per cent less rolling stock is used in this service. These improvements open the way to still further savings.

The Lift-Truck Manufacturers' Part in Extending the Program of Skid Shipments of Commodities

By F. J. SHEPARD, Jr.

Treasurer, Lewis-Shepard Co., Watertown, Mass. Jun. A.S.M.E.

IF THE plan to widen the use of lift-truck platforms in the shipment of commodities is to be successfully carried out, a comprehensive program of standardization is required of the manufacturers of lift-truck equipment. It is necessary that both skid platforms and lift trucks be of dimensions that will permit a truck of one make and type to load skids on cars or boats from which they may be removed by a lift truck of any other make or type.

This plan does not mean that individuality of different makes is to be in any way sacrificed. Neither does it mean that equipment at present in service must be scrapped in favor of apparatus of different dimensions. But the widths of platforms and the amount of lift of new equipment made and sold may have to conform to certain limits which will gradually become universal, while in the meantime they will not mark radical departures from present dimensions.

The program therefore requires careful consideration and cooperative action to make the transition period of one convenient and economic progress to the ultimate objective where new equipment conforming to the revised standards will have gradually supplanted worn-out or obsolete equipment.

The Materials-Handling Problem in the Public Utility

By JOHN C. SOMERS

Production Engineer, Baltimore, Md. Assoc-Mem. A.S.M.E.

IN THIS paper the author makes a definite attempt to summarize the problem of materials handling in the public-utility field, with specific reference to the central-station industry.

The Use of Skids for Water Shipments

By H. E. STOCKER

Traffic Engineer, Munson McCormick Lines, New York, N. Y.

ECONOMICAL handling of commodities in bulk has been highly developed, but great reductions in costs are possible with other classes of cargo by the use of advanced methods and equipment and the application of principles which have accomplished so much in manufacturing. The principles of greatest importance are the reducing of handling to the minimum and increasing the production of equipment to the maximum.

In the shipping industry handling may be reduced by keeping freight off the floor of the dock or the deck of the ship. The best method of accomplishing this is to receive the freight from the manufacturer already loaded on a skid. It broadens the application of the principle by extending it back to the mill where the goods are manufactured. Savings are increased not only by reducing handling at the mill and at point of consumption but by reducing packing expenses.

Marine operations are fundamentally divided into two classes, one in which the freight is loaded through side ports and the other in which the freight is loaded over-all through the hatches.

An example of the first operation is found in a steamship line operating from Portland, Me., to New York. Shipments of a paper on skids are loaded into a car at the mill by a hand-lift truck, then unloaded at Portland and taken into the ship through a side port with a lift truck. On arrival at New York the skids are then taken from the ship by a hand-lift truck hauled by an electric tractor. The tractor is used because the skids must be hauled a long distance to a bulkhead at the head of the dock. The bulkhead is used in conjunction with a runway and a hand winch in loading the skids on the consignee's motor trucks. In addition to the savings to the mill, the railroad, and the printer, the steamship company saves about 50 per cent.

When the floor of the dock at New York is improved one man and a tractor will handle skids averaging 3600 lb. in weight with a total saving as compared with shipments in cases of over 80 per cent.

Even more important from the standpoint of net profit is that additional business has been brought to the line by accepting shipments on skids.

In addition to the economy resulting from handling skids on the dock with lift trucks, the average slingload will be increased approximately 300 per cent, the ship's dispatch will be expedited, and the claims reduced. Total savings will be the equivalent of more than a 50 per cent cut in cargo-handling expenses.

With the increased use of skids for water shipments, there will come a greater use of mechanical equipment with its many advantages.

Skid Shipments

By GEO. B. WRIGHT

Freight Traffic Manager, Detroit & Cleveland Navigation Co., Detroit, Mich.

THE author discusses skid platforms, stock skid boxes, power-lift and hand-lift trucks in the handling of cargoes in Great Lakes navigation. He points out that the biggest problem to be faced is the practicability of interchange between carriers, and between carriers and industrial plants. The solution can only be arrived at through discussion between representatives of industries, steam railroads, electric lines, steamer lines, city transfer trucking companies, and storage warehouses.

PRINTING

Air Conditioning in the Printing and Lithographing Industries

By WILLIS H. CARRIER[1] and ROBERT T. WILLIAMS

Carrier Engineering Corporation, Newark, N. J. ([1] Mem. A.S.M.E.)

THE problem of air conditioning in printing and lithography resolves itself into reproducing in those portions of the plant where conditions of humidity, temperature, cleanliness, and air circulation affect materials or processes, those natural atmospheric conditions which the trade has found by long experience give the best results. This involves the control of regain by such hygroscopic materials as paper and printers' rollers; the maintenance of a humidity sufficiently high to prevent the generation of static electricity and sufficiently low to prevent "water-logged" rollers and paper; the maintenance of temperatures at which ink has the required viscosity and flow and rollers the right amount of "tack;" the elimination, in so far as is commercially practicable, of floating dust; and the maintenance of comfortable working conditions.

Ink

By JULIUS FRANK

Sigmund Ullman Co., New York, N. Y.

INK is one of the raw materials in the printing process. Good work in the pressroom is strongly influenced and governed by atmospheric conditions, the trials and tribulations of which, though obscure to the layman, are appreciated by the pressman, who daily comes in contact with the peculiar requirements of the pressroom.

The behavior and actions of atmospheric conditions upon printing are such that each and every difficulty as it comes up must be dealt with as a problem of its own. It often happens that the appearance of a carefully planned "job" under one condition is marred by other conditions caused by the unexpected change in atmosphere, such as a sudden drop from dry to humid weather, from hot to cold, or vice versa.

Atmospheric conditions are the causes of the many difficulties in the pressroom such as static, offset, swelling, and shrinking of packing, rollers expanding, ink becoming too thin, chilling of varnish in the ink, causing the ink to become tacky, paper becoming distorted and thereby rendering it difficult to obtain good register.

These and many other such difficulties have been obstacles to good presswork. How to deal with them is a problem which the author believes should be solved at this advanced stage of the printing art.

Heat-Drying Equipment for Printing Presses

By CHARLES HENRY COCHRANE

New York, N. Y.

THE author states in this paper that it is essential in securing good-quality printing at modern high speed that the pressroom be uniformly heated a little above the comfort point; that the moisture content of the air be uniform and harmonious with the moisture content of the paper; that the composition ink rollers be suited to the heat and moisture conditions; and that the inks be suited to the paper, the heat, and the moisture conditions.

Whenever any of these four conditions are out of harmony, printing cannot proceed smoothly. The time has arrived when the paper makers, the manufacturers of humidizing apparatus, and the ink makers should cooperate to establish a standard percentage of moisture to be adhered to both for paper and pressroom, so that the ink maker can supply inks suited to this standard condition. At the present time we all know that pressrooms will be heated pretty uniformly to near 75 deg. fahr., but since the humidity may run from 20 to 90 per cent and the moisture content of the paper from less than two to eight per cent, the resultant inharmony is bound to be a nuisance and expense to the printer and allied trades.

Paper

By OTTO WALTER FUHRMANN

Typographic and Production Engineer, Blanchard Press, New York, N. Y., Chairman Educational Commission, International Association of Printing House Craftsmen

PAPER is one of those materials used in one of the leading industries that has not undergone any basic changes in its manufacture. Papermaking has been refined to a remarkable degree since it first was practiced in Europe in the fourteenth century, but the fibrous nature of the product, whether hand- or machine-made, remains the same, and the resulting influence of temperature and humidity changes upon printing production is very pronounced. Precision engineering methods have been applied to type, engravings, plates, presses, feeding devices, inks—in short, to materials and methods in the production end of the printing industry, and also in the manufacture of paper; but the handling of paper under greatly varying conditions has not received proper attention, and as a consequence there are conditions such as static electricity, offset of ink, stretch and shrinkage on register work, and cracking on the fold that present serious problems and are real obstacles to smooth and economic production. The author calls attention to some fundamentals so that troubles encountered may be minimized by attacking their source instead of following the present tendency of using palliatives.

Static Electricity

By WM. C. GLASS

Vice-President, United Printing Machine Co., New York. Mem. A.S.M.E.

THIS paper deals with the trouble encountered with static electricity in the handling of paper and textiles in the printing and textile industries and describes the method by which they may be eliminated by the Chapman electric neutralizer. The nature of the trouble is discussed and the principle underlying the neutralizer is explained. Numerous examples of the value of the neutralizer in both the printing and textile trades are cited by the author.

The Grammer Process for Prevention of Offset

By J. S. PECKER[1] and H. C. COLE

Machine and Tool Designing Co., Philadelphia, Pa. ([1] Mem. A.S.M.E.)

THE Grammer process for prevention of offset consists in atomizing wax in a molten state and distributing the innumerably minute and chilled wax particles over the surface of the paper, causing these hardened particles to act as a mechanical separation between the sheets while the ink is drying.

The device embodies new principles of quantity control in atomization, and automatic and synchronous adjustment of any number of nozzles to spray in like quantities.

The process effects many savings in cost of commercial color printing, increases production, and eliminates waste in material and handling. It is believed that it will influence changes, improvements, and development of new presses for greater production in color printing, making it possible for the printing of innumerable colors on both sides of a sheet with one pass through the press, at higher speeds.

RAILROAD

The Balancing and Dynamic Rail Pressure of Locomotives

By R. EKSERGIAN

Engineering Department, The Baldwin Locomotive Works, Philadelphia, Pa. Mem. A.S.M.E.

THE problem of counterbalancing for minimum dynamic loading and rail stress is a basic design limitation for modern locomotives with limited axle loads. Two methods of balance are ordinarily used: static balancing, where the difference in planes of the revolving weights is not taken into consideration; and dynamic balancing, where the planes of action are considered as well. As the former method is extensively used, the estimation of maximum rail pressure with the heavy overhanging revolving weights is of considerable importance.

An analysis is made, resulting in formulas and general methods for the determination of the maximum rail pressure and the corresponding position of the crank for systems of revolving weights. A complete outline of balancing methods is included.

The balancing of the reciprocating parts introduces unbalanced vertical components. A general study is made of the dynamic effect of the reciprocating parts and revolving parts on the locomotive itself, both for two- and three-cylinder locomotives, counterbalanced statically and dynamically.

Next comparative studies are made of the relative effects when statically and dynamically balanced for two-cylinder locomotives; that is, as to rail pressure and the vibration of the locomotive itself. A similar comparison is made of the dynamic loadings for two- and three-cylinder locomotives.

A brief survey is made of the nature of rail stress and the effect of counterbalance and wheel spacing in augmenting the bending moment in the rail.

Calculations are included for the rail and track loading of a Mountain type, an 8-coupled, and a three-cylinder compound locomotive. Finally, a study of weight transfer under maximum traction is made, including calculations therefor with a Santa Fe type locomotive.

The appendix contains special problems, as the general formula for the vertical thrust of the connecting rod on the main pin, and an estimation of revolving weight, with experimental methods of determining the constants of a rod. The general dynamical equation of a locomotive for the fore-and-aft and nosing oscillations is also included.

The conclusions are that the cross or dynamic balance of main drivers should be made with modern power, and that the allowable axle loadings should be based on the maximum rail and track loading at the average operating speeds.

Characteristics of Injectors, With Special Reference to Their Utility as Locomotive Feedwater Heaters

By R. M. OSTERMANN

Vice-Pres., The Superheater Company, Chicago, Ill. Mem. A.S.M.E.

SINCE the preheating of water fed to locomotive boilers by exhaust steam has become more fully recognized on American railroads, and since apparatus designed for that purpose is being applied in increasing quantities in this country, the author deems it of interest to again review the possibilities of injectors, and particularly injectors working with exhaust-steam pressures—so-called exhaust-steam injectors—which latter have found considerable use on European locomotives, but which have, more recently, had the attention of American railroads also.

The Schmidt High-Pressure Locomotive of The German State Railway Company

By R. P. WAGNER

Superintendent, Locomotive Department, Deutsche Reichsbahn-Gesellschaft, Berlin, Germany. Mem. A.S.M.E.

IN THIS paper the author gives the details and road-test data of a locomotive having a boiler which generates steam at two pressures, 850 lb. and 205 lb., using the 850-lb. in a center cylinder and its exhaust, mixed with the 205-lb. steam in two outside cylinders.

Refrigeration in Railroad Freight Cars

By J. W. MARTIN, Jr.

Dry Ice Corporation of America, New York

SOLID carbon dioxide, under the trade name of "Dry Ice," has been a commercially important refrigerant for but a comparatively short time. The product is a white solid, heavier than water ice, and evaporates at a temperature of —109 deg. fahr. As it evaporates it gives off carbon dioxide, a non-poisonous, non-odorous gas possessing a high degree of insulating effect.

Solid carbon dioxide may be considered more as a source of highly improved insulator than as a refrigerant. As a refrigerant it possesses only about twice the refrigeration effect of water ice, but by using the offcoming gas as a moving blanket of insulation the actual amount of refrigerant required is many times less.

Several carloads of frozen fish and of unfrozen meat and meat products have been shipped successfully under dry-ice refrigeration, and the building of an improved refrigerator car suitable for use with this refrigerant is under way. It is thought that the advantages of using solid carbon dioxide as a refrigerant in cars will be:

1 Saving in refrigerant because of the insulating effect of the carbon dioxide gas
2 Saving in spoilage of lading:
   a Because of the possibility of getting lower temperatures when needed
   b Because of uniformity in temperature within the car

3 Saving in weight of refrigerant, giving a lighter car
4 Increase in available space within the car for lading
5 Saving in time and expense of reicing. Initial icing is sufficient for full trip
6 Saving in maintenance of car and tracks due to absence of drip
7 The fact that it is non-mechanical and foolproof.

WOOD INDUSTRIES

Ball Bearings as Applied to Woodworking Machinery

By H. E. BRUNNER

Chief Engineer, S.K.F. Industries, Inc., New York. Mem. A.S.M.E.

ANTI-FRICTION bearings of the ball and roller type are extensively used in almost all classes of woodworking and sawmill machinery. The ball bearing is employed to meet those conditions where high speeds and moderate loads prevail, while the roller bearing is used where lower speeds and relatively heavy loads exist. Both types have successfully met the exacting requirements imposed upon them. Their introduction has been due mainly to the difficulties experienced with plain bearings, such as—

a Unreliable service at high operating speeds
b Control of running clearance and vibration resulting from wear
c High maintenance cost of lubrication
d Liability of plain bearings to breakdown and fire hazard.

The author further discusses applications and divides them into three groups as follows:

1 Heavy-Duty Sawmill Machinery
2 Low-Speed Woodworking Machines, Non-Precision Type
3 High-Speed Woodworking Machines, Precision Type.

The Application of Universal Chucks to Woodworking Machinery

By E. A. ENGLUND

Chief Engineer, The Jacobs Mfg. Company, Hartford, Conn.

THE purpose of this paper is to direct the attention of engineers interested in woodworking practice to the economies and improvements to be secured by the use of universal chucks on woodworking machines. This is particularly true in connection with boring and routing machines and lathes, where the use of a universal chuck will eliminate the need of special spindle or tool construction, and provide for a rapid change of tools and a more accurate-running tool bit. This higher degree of accuracy will in turn result in less tool breakage, closer production tolerances, and decreased wear upon the bearings of the machine. Methods of mounting such chucks on present-day equipment are discussed and suggestions made for future spindle development.

Lubrication of Ball-Bearing Woodworking Spindles

By HARRY R. REYNOLDS

Chief Engineer, Fafnir Bearing Co., New Britain, Conn.

THE purpose of this paper, the author states, is to bring out methods of lubrication especially suitable for speeds ranging from 4000 to 7500 r.p.m., which is about the range of woodworking spindles.

The author sums up by stating that where oil is used its level should not be over the center of the lowest ball if speeds are higher than 5000 r.p.m. At 5000 to 5700 r.p.m. a very light spindle oil should be used, and it should be fed either by wick or circulation from pump as any depth of oil around the balls will cause tremendous churning. Too much oil should not be used as it will cause heating, and the higher the speed the greater the heat.

If grease of the proper consistency is used, the housing can be filled. At high speed there will be a path cut through the grease by the balls, and if temperature develops, just enough melting will occur to furnish the lubrication required. Greases soft enough to churn should be avoided for high-speed applications, as the heat generated will melt them so fast that conditions will duplicate those of too much oil. Failure is generally due to dirt, so the bearings must be kept clean. Especial care should be taken in renewing the lubricant, as this is when most of the dirt gets in.

Reducing Waste by Improvement of Design and Use of Woodworking Saws and Knives

Progress Report of the A.S.M.E. Special Research Committee on Saws and Knives

THIS first progress report of the A.S.M.E. Special Research Committee on Saws and Knives outlines the problem and indicates some of the fundamentals to be observed in the further development of the subject, as well as some details which it has been possible to work out.

There are many reasons why standardization is essential in the various arts that comprise mechanical engineering, but in this report special emphasis is placed on three factors: (1) Economic utilization of lumber, or the reduction of wastage in sawdust and shavings to a minimum point consistent with the cutting apart of the pieces of lumber and the machining to the desired shapes and sizes; (2) conservation of power, or the reduction of the power factor in the operation of saws and knives to a minimum requirement; and (3) the selection and classification of the most effective types, sizes, and shapes of tools to produce the above results.

Saws and knives are used on a multitude of machines which are not specified in this report, but the Committee believes, however, that the lists outlined are basic and fundamental and subject to substantial expansion as its research work is further developed.

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THE ENGINEERING INDEX

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Mechanical Engineering Section

THE ENGINEERING INDEX furnishes a Weekly Card Index Service of references to the periodical literature of the world covering every phase of engineering activity, including Aeronautic, Chemical, Civil, Electrical, Management, Mechanical, Mining and Metallurgical, Naval and Marine, Railway, etc. Items of particular interest to mechanical engineers are selected for presentation each month in this Mechanical Engineering Section. In operating The Engineering Index, The American Society of Mechanical Engineers makes available the information contained in some 1700 technical publications received by the Engineering Societies Library (New York), thus bringing the great resources of that library to the entire engineering profession.

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AIRPLANE ENGINES

Lubrication. Development of Aircraft Engine Design and Lubrication. Lubrication, vol. 14, no. 7, July 1928, pp. 73–84, 17 figs. Engine-oil requirements; government specifications; reasons for viscosity requirements; requirements for specific types of engines; principles of lubrication.

AIRPLANE PROPELLERS.

Variable Pitch. The Variable Pitch Propeller, H. S. Hele-Shaw and T. E. Beacham. Airway Age, vol. 9, no. 8, Aug. 1928, pp. 35–39, 8 figs. Description of new system of hydraulic control on Gloster Hele-Shaw Beacham variable-pitch propeller; its weight, reliability, and provision for failure are discussed; pitch of blades varied by double-acting hydraulic piston operated by oil pressure from variable-stroke pump driven by engine; stroke of pump controlled by governor which can be varied by pilot. Paper presented before Roy. Aeronautical Soc.

AIRPLANES

Tail Surfaces, Design. Study of Horizontal Tail Surfaces of Consolidated XPT-3 (NY-1). Air Corps Information Circular, vol. 7, no. 615, Aug. 15, 1928, 8 pp., 7 figs. Study to improve landing characteristics of XPT-3 airplane by redesigning horizontal tail surfaces; desired larger stalling moments obtained by proposed tail are effective only at low speed and do not alter balance with elevators free at 85 mi. per hr.; decreased slope of pitching coefficient improves control throughout entire range of flying; somewhat increased stick forces can be offset by use of balanced elevators.

WINGS. Pressure Distribution Over a Rectangular Monoplane Wing Model Up to 90 Deg. Angle of Attack, M. Knight and O. Loeser, Jr. Nat. Advisory Committee for Aeronautics, Report, No. 288, 1928, 19 pp., 34 figs. Description of pressure-distribution tests made on wing model in atmospheric wind tunnel of Langley Memorial Aeronautical Laboratory; these tests indicate that rectangular wing, by reason of its large tip loads, is uneconomical aerodynamically and structurally, has pronounced lateral instability above maximum lift, and is not adaptable to accurate calculation based on classical wing theory.

16th Wilbur Wright Memorial Lecture, F. H. Handley Page. Roy. Aeronautical Soc.—Jl. (Lond.), vol. 32, no. 212, Aug. 1928, pp. 649–704 and (discussion) 704–705, 62 figs. Wind-tunnel experiments showing how aerodynamic characteristics of wing section are altered by slot, are described, and best application of Handley-Page slotted wing for control purposes is explained; with correctly designed and positioned auxiliary airfoil, opening and closing automatically, very good control at beyond stall can be obtained without added complication of control by forward airfoil.

Slotted Wings and the Automatic Slot, F. H. Page. Engineering (Lond.), vol. 126, no. 3265, Aug. 10, 1928, pp. 180–182, 11 figs. Account of research work, of which salient features are summarized, as follows: with thick wing sections increase in lift coefficient can be obtained by use of slot equal in magnitude to that with thin wings; similar result in stalled flight can be obtained with both thick and thin sections; if increased control is required at and beyond stall, particularly at very high angles of incidence, controlled slot or "interceptor" should be used, etc.

AIRPORTS

Chicago Ill. Chicago's Municipal Airport an Institution. Airports, vol. 1, no. 3, July 1928, pp. 27 and 38, 1 fig. Description of Chicago airport; four cinder runways having total length of over 10,000 ft.; two revolving beacons, two large unit-type floodlights, and huge ceiling projector; nine hangars.

AIRSHIPS

Zeppelin. The German Dirigible, L. Z. 127, C. H. Pollogg. Aero Digest, vol. 13, no. 3, Sept. 1928, pp. 448 and 450, 5 figs. Description of Zeppelin dirigible "Graf Zeppelin;" main building material is special alloy even lighter and stronger then duralumin; new gaseous fuel to be used; length 778 ft.; displacement 3,700,000 cu. ft.; maximum speed 80 m.p.h.; pay load 14.8 tons; passenger capacity 20; 5 Maybach V.L. 2 engines of 530 hp. each.

ALIGNMENT CHARTS

Design. A New General Method for the Design of Nomograms [Ueber ein neues allgemeines Verfahren zum Entwerfen von graphischen Rechentafeln (Nomogrammen), insbesondere von Fluchtlinientafeln], A. Fischer. Zeit. fuer angewandte Mathematik und Mechanik (Berlin), vol. 8, no. 4, Aug. 1928, pp. 309–335, 36 figs. Third chapter of work on theory and applications of monography theory of alignment charts drawn on pseudosphere or any other surfaces; application of theory to problems involving three or more variables.

ALLOYS

Aluminum. See ALUMINUM ALLOYS.

Bronze. See BRONZE.

Chrome-Nickel. See CHROMIUM-NICKEL ALLOYS.

Equilibrium Diagrams. Equilibrium Diagrams in Studying Alloys, W. Rosenhain. Heat Treating and Forging, vol. 14, no. 7, July 1928, pp. 734–739, 3 figs. Practical explanation of scientific methods in study of alloys and results gained; metallurgical explanation of age-hardening; principle of phase rule; energy potential and metastable alloys; thermal analysis; dilatometry; alloying and its results; limiting solubility curve; influence of quenching; high-tensile beryllium alloy. Abstract from presidential address to Institute of Metals.

Heat-Resisting. Heat-Resisting Alloys, T. H. Turner. Am. Metal Market, vol. 35, no. 155, Aug. 14, 1928, pp. 17–20, and 22–23. Considerations of alloys used for specific industrial purposes such as in steam engineering furnace work, electric machinery, internal-combustion engines, guns, and rifles, hot forging dies and chemical engineering.

Zinc. See DIE CASTING.

ALUMINUM ALLOYS

Chlorine Treatment. Note on the Treatment of Aluminium and Aluminium Alloys With Chlorine, D. R. Tullis. Inst. of Metals—Advance Paper (Lond.), no. 480, for mtg. Sept. 4–7, 1928, 8 pp. Most aluminum alloys contain dissolved gases; methods for their removal are described as follows: slow solidification, inert-gas, and active-gas methods; experiments are described in which chlorine gas is used as means of remixing dissolved gases; theory is advanced to account for presence of gases in metals; effects of chlorine gas on alloys which are known to extrude metal while cooling, and alloys which are known to disintegrate after long or short periods of storage.

Fits. How Temperature Affects Fits in Aluminum Alloys. Am. Mach., vol. 69, no. 8, Aug. 23, 1928, p. 311. Builders of automobile engines have experienced difficulty with fit of rods on crankpins in extremes of temperature; customary to allow little more rod clearance in winter

NOTE.—The abbreviations used in indexing are as follows:
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

than in summer; additional clearance of 0.0004 in. is allowed for new engines that go into service in winter months; experiments with steel reinforced and alloy caps; Franklin and Hupp practice.

Hyb-Lum. Lightness and Strength Combined in New Aluminum Alloy. Automotive Industries, vol. 59, no. 8, Aug. 25, 1928, pp. 266–267. "Hyb-lum" marketed by Sheet Aluminum Corp., Jackson, Mich., as non-tarnishing and non-corrodible and is stable after heat treatment even at elevated temperatures; supplied in four grades; physical properties of each grade are given.

Welding. Spot Welding of Aluminum and Its Alloys, W. M. Dunlap. Aviation, vol. 25, no. 9, Aug. 25, 1928, pp. 590–591 and 618–626, 10 figs. Recommendations for spot welding as developed in laboratories of Aluminum Co. of America; machines with automatic timers best; size and shape of electrode tip important; copper tips chromium plates; setting up machine; strength of joints depends on number of spots; range of thickness that can be spot welded varies with capacity of machine.

AMMONIA COMPRESSORS

Temperature-Pressure Relations. Temperatures and Pressures in Ammonia Systems, A. G. Solomon. Power Plant Eng., vol. 32, no. 17, Sept. 1, 1928, pp. 941–942, 1 fig. Practical information on temperature-pressure relations in refrigerating systems of interest to operating engineers; tables giving properties of ammonia; factors affecting degree of superheat; arrangement of piping in fore-cooler affects ammonia temperature.

AUTOMOBILE ENGINES

Connecting Rods, Manufacture. How Citroen Makes Connecting Rods. Am. Mach., vol. 69, no. 9, Aug. 30, 1928, pp. 348–349, 7 figs. Illustrations of methods employed with brief descriptions of each figure; indexing fixture for milling; fixture for drilling hole for piston pin; rough boring the large end; weighing rods for mass and for balance; testing alignment of rods and pistons; reaming large end of rod, etc.

Connecting Rod Strain Eliminated During Machining Operations, K. W. Stillman. Automotive Industries, vol. 59, no. 8, Aug. 25, 1928, pp. 268–269, 5 figs. Methods employed at Olds Motor Works do away with need for straightening as work progresses; minimum strains set up in forging.

Cylinders, Manufacture. Unique Locating Method Employed in Finishing Cylinder Blocks, K. W. Stillman. Automotive Industries, vol. 59, no. 9, Sept. 1, 1928, pp. 296–298, 6 figs. Oldsmobile does not depend on bottom surface as means of location, but uses crank holes for accurate line-up during finishing operations on bores; description of operations.

Detonation. Influence of Engine Design on Detonation (L'influence du dessin du moteur sur al détonation Ricardo. Technique Automobile et Aérienne (Paris), vol. 19, no. 142, 1928, pp. 75–79. Discussion of detonation, causes, prevention, form of combustion chamber, merits of various forms; influence of cylinder dimensions of detonation.

Supercharging. The Application of Superchargers to Automotive Vehicles, L. Schwitzer. Soc. Automotive Engrs.—Jl., vol. 23, no. 2, Aug. 1928, pp. 174–178, 3 figs. Most passenger automobiles are overpowered and probably 80 per cent of such vehicles operate at less than 35 m.p.h. for 90 per cent of time; smaller engines used to advantage where equipped with superchargers for use when excess power is required; results of comparative tests shown; advantages of supercharging motor coaches; advantages of Roots supercharger and efficient wing section to use in it.

AUTOMOBILE PLANTS

Heat Treating in. Dodge Electrifies Heat Treatment. Iron Age, vol. 122, no. 7, Aug. 16, 1928, pp. 389–392, 5 figs. Details of electric heat-treating furnaces used in plant of Dodge Brothers, Inc.; two separate heat-treating departments, one for finished machine parts and one for forging; over 60 furnaces drawing total current of 11,400 kw.; unique charging devices; one battery handles 450,000 lb. of rough forgings daily; hearth floor consists of three alloy plates locked at one end and alloy steel wall 10 in. high; heat is transmitted through alloy bottom.

Heat Treating Equipment in a French Motor Plant. Am. Mach., vol. 69, no. 8, Aug. 23, 1928, p. 323, 3 figs. Three halftones illustrating heat-treating furnaces and materials handling in plant of André Citroen, Paris; furnaces and recording mechanism used in ball-bearing department; types of furnaces used for heat-treating crank-shafts, camshafts and piston pins; method of handling car loads of materials to be heat-treated or carburized.

Materials Handling in. How Packard Handles Twice Last Year's Output, E. F. Roberts. Mill and Factory Illustrated, vol. 2, no. 1, Aug. 1928, pp. 34–42, 20 figs. A flexible handling system with constant refining in planning takes care of about 100 per cent higher production rate without overload at plant of Packard Motor Car Co.; company builds all parts of nearly 6000 cars a month; description of operations in four principal production units, viz., foundry and forge groups, pressed-steel unit, body plant, main machine and assembly unit.

AUTOMOBILES

Bodies, Steel. Sheet Steel for Automobile Bodies. Heat Treating and Forging, vol. 14, no. 8, Aug. 1928, pp. 856–862, 7 figs. Normalizing of sheet steel gives to automobile industry sheets capable of taking most difficult shapes used on rapidly changing models with minimum amount of breakage and scrap loss; methods of normalizing as well as its development, are discussed; mechanical equipment and metallurgical control; continuous annealing of sheets by normalizing has eliminated at least one box annealing and produced in sheet such properties that it is suitable for use on many parts.

Brakes. A New Vacuum Servo. Automobile Engr. (Lond.), vol. 18, no. 244, Aug. 1928, pp. 289–290, 5 figs. De Monge system which is interesting mechanism by means of which braking is directly proportional to pedal pressure; control valves as well as brakes are directly connected to foot pedal; device does not rely on piston rings, glands, or other frictional members to prevent leakage; automatic safety valve.

Frames, Manufacture. Making Automobile Frames Automatically. Iron Trade Rev., vol. 83, no. 8, Aug. 23, 1928, pp. 441–443 and 483, 5 figs. Article deals with automatic production of automobile frames by A. O. Smith Corp., Milwaukee; rates of speed maintained in automatic plant is between 300 and 360 frames per hour; description of equipment and operation.

Front Axles, Manufacture. How Ford Makes Front Axles, F. L. Faurote. Iron Age, vol. 122, no. 8, Aug. 23, 1928, pp. 457–460, 7 figs. Method of forging and forming Ford front axles is outlined; after cutting to length, 40-in. forging machine is used to upset and bend each end, and 5000-lb. hammer and press are employed for blocking, finishing, and trimming; bench inspection follows, after which parts are heated in central section and bent and stretched to proper length in special press.

Front-End Drive. Front-Wheel Drives, Are They Coming or Going? H. Chase. Soc. Automotive Engrs.—Jl., vol. 23, no. 3, Sept. 1928, pp. 249–270 and (discussion) 270–271, 39 figs. Advantages and limitations of front-wheel drive specifically discussed; opinion expressed that this form of drive is likely to be in extensive use in United States within next few years; numerous illustrations of different types of front-wheel-drive vehicle are presented and their most important features are enumerated and explained.

Inspection. Inspection Methods and Their Application, F. H. Colvin. Am. Mach., vol. 69, nos. 8, 9 and 10, Aug. 23, Aug. 30 and Sept. 6, 1928, pp. 305–310, 343–346 and 387–391, 43 figs.

Aug. 23: Inspecting cylinder blocks by two methods; in one, reliance for accuracy is placed in fixtures; in other, inspection is made between operations; methods in Hupp, Chrysler and Graham-Paige plants are compared.

Aug. 30: Practices in various automobile shops showing how final boring of connecting rods is done, and methods of checking parallelism of holes. Sept. 6: To allow for uniform thickness of oil film on crankpin bearings, many automotive plants inspect connecting rods with view to selective assembly; describes inspection methods of Hupp, Chrysler, Continental and Graham-Paige plants.

Springs, Standardization. Leaf-Spring Standards. Soc. Automotive Engrs.—Jl., vol. 23, no. 3, Sept. 1928, pp. 321–322, 3 figs. Present spring and spring parts specifications, as revised and consolidated by Subdivision of Passenger Car Division, are given and include leaf springs, leaf-spring steel, leaf-spring tests, and tests for parallelism of spring eyes.

Transmissions. The Lescarts Variable-Speed Transmission Gear (Appareil de transmission à vitesse variable système Lescarts), A. Dumont. Genie Civil (Paris), vol. 93, no. 4, July 28, 1928, pp. 93–95, 4 figs. Principles of design, construction and tests of Lescarts gear, its use in automobiles, and other prospective uses.

AUTOMOTIVE FUELS

Anti-Knock Compounds. Iron Carbonyl: The German Anti-Knock Compound. Petroleum Times (Lond.) vol. 20, no. 497, July 21, 1928, p. 108. Researches have proved that crude benzol can be refined into high-grade motor fuel when used alone; supplies are too limited for general use; Benzol-Verband has found blends of benzol or alcohol with petroleum fuel satisfactory; most important anti-knock fuel in Germany is "Motalin," which is doped petroleum motor fuel in which added chemical is iron carbonyl Fe (CO) 5; said to be non-poisonous; 0.1 per cent sufficient.

Detonation. Spectroscopic Study of Fuels and Analysis of Detonation Theories, G. L. Clark, Soc. Automotive Engrs.—Jl., vol. 23, no. 2, Aug. 1928, pp. 167–173, 1 fig. Different commercial gasolines examined by means of ultra-violet spectra of their detonation flames; study yielded valuable information in regard to combustion, explosion, and detonation; action of detonation studied; list of 12 theories of action of knock suppressors given with evidence for and against each; no single theory yet propounded seems entirely satisfactory.

B

BLOWERS

Forced-Draft. Westinghouse Forced-Draft Blower of the Schmidt Propeller Type, J. B. Lincoln and B. F. Treat. Am. Soc. Naval Engrs.—Jl., vol. 40, no. 3, Aug. 1928, pp. 424–437, 9 figs. Article describes and gives results of tests made at U. S. Naval Eng. Experiment Station on Schmidt vertical blower manufactured by Westinghouse Electric & Mfg. Co.; tests cover performance of fan at various speeds and capacities and performance of combined unit; description of blower.

BOILER FEEDWATER

Treatment. A Non-Chemical Method for the Prevention of Scale Accumulation in Boilers, Diesel-Jackets, and Water-Circulating Systems in General, A. T. Ridout. Inst. Mar. Engrs.—Trans. (Lond.), vol. 40, July 1928, pp. 333–340 and (discussion) 340–350. A physical system of water treatment intended to dispense with chipping hammer and zinc plates in boilers and allow use of water for make-up feed; for evaporators to keep them free from all scale formation and in certain circumstances, in Diesel-engine jackets; based on use of true colloids as distinct from so-called "colloids;" acid and galvanic actions in boilers arrested; low upkeep cost, small space for apparatus.

BOILER FURNACES

Pulverized-Coal. Experiences in Changing to Pulverized Coal, M. J. Gearing. Power Plant Eng., vol. 32, no. 17, Sept. 1, 1928, pp. 914–918, 3 figs. Changing from stokers to pulverized-coal equipment necessitated some experimenting at Diamond Crystal Salt Co. plant; choice was made of unit system; coal is fed to pulverizers from overhead bunker, first passing through automatic coal scales; correcting initial difficulties; slagging at high ratings; furnace operation improved by water cooling; burners of turbulent type; maintenance costs.

Regulation. Automatic Regulation of Boiler Furnaces (Selbsttaetige Reglung von Feuerungen fuer Dampfkessel), H. Treitel. Archiv fuer Waermewirtschaft (Berlin), vol. 9, no. 8, Aug. 1928, pp. 249–255, 11 figs. Author discusses requirements and principles governing regulation of boiler furnaces, and describes Bailey-Roucka, and AEG-Askania regulators; regulation according to carbon-dioxide content; regulation for large and high-pressure boilers.

BOILER SCALE

Formation of. Theoretical and Experimental Study of the Formation of Scale in Boilers (Etudes théoriques et expérimentales sur la formation des incrustations de chaudières), R. Stumper. Chimie et Industrie (Paris), vol. 20, no. 1, July 1928, pp. 10–20, 5 figs. Chemistry of steam boilers; theory and physico-chemical aspects of formation of scale; formation of scale bed. Bibliography.

BOILERS

Corrosion Prevention. Corrosion of Boilers Checked by Electrochemical System, O. W. Garrick. Eng. News-Rec., vol. 101, no. 6, Aug. 9, 1928, p. 209. Summary of paper on electrochemical polarization system that has given satisfactory results when applied to locomotives and is said to be applicable also to boilers of water works and other utility and industrial plants; flow of electric current is maintained in boiler, with arsenic in water; trails show good results.

High-Pressure, Manufacture. Construction of High-Pressure Boiler Drums (La construction des corps de chaudières à haute pression). Génie Civil (Paris), vol. 92, no. 16, Apr. 21, 1928, pp. 392–393, 2 figs. Method employed by firm

of Thyssen (Mulheim) is described; rolling mill capable of dealing with 30-ton ingots is used to produce plates of 16 to 18 tons; after trimming plates and beveling two edges in preparation for lap welding, drum about 4 ft. in diameter can be formed with single longitudinal seam; welded drum is heated to 900 deg. cent. in order to remove all internal stresses.

Lancashire. Modern Possibilities of the Lancashire Boiler, C. F. Wade. Colliery Eng. (Lond.), vol. 5, no. 53, July 1928, pp. 271–274, 7 figs. Important developments suitable for application to coal-mine boiler plants are reviewed; use of low-grade fuel; economizers and superheaters; steam accumulation.

Pulverized-Fuel Firing. Latest Developments in Pulverized Fuel Firing. Iron and Coal Trades Rev. (Lond.), vol. 117, no. 3153, Aug. 3, 1928, p. 157, 2 figs. Brief description of installation of Lopulco pulverized-fuel firing equipment at Neasden power station of Metropolitan Railway; also mentioned other plants where pulverized fuel is used.

Waste-Heat. Steel Plant Waste Heat Boilers, R. H. Stevens. Blast Furnace and Steel Plant, vol. 16, nos. 7 and 8, July and Aug. 1928, pp. 931–935 and 1050–1053, 5 figs. July: Economies effected by recovery of heat from waste furnace gases; not performance of boiler itself as steam producer, but its effect upon attached furnace is ultimate justification for its installation; August: Complete utilization of heat by primary heating unit promotes economies in excess of those represented by performance of boiler; waste-heat boiler can make best showing where reclaimed energy is not required directly by process from which it came. Paper delivered before Am. Iron and Steel Inst.

BONUS SYSTEMS

Group. Group Incentives in the Eberhard Manufacturing Company, B. Shepard. Am. Mgmt. Assn.—Production Executives Series, no. 72, 1928, pp. 19–22. Details of group piece-work plan employed by company manufacturing malleable-iron castings, employing between 500 and 700 workers; savings effected.

Group Payment Plan of the National Cash Register Company. R. F. Whisler. Am. Mgmt. Assn.—Production Executives Series, no. 73, 1928, pp. 7–18. Discussion of experience of National Cash Register Co. with group bonus and comparison of results with different methods; applications and limitations of group bonus; rules of operation; effect upon quality, direct labor, indirect labor, inventory cost, and budgetary control.

BRAKES

Internal Expanding. Differential Internal Expanding Band Coupling or Brake with Linked Bands (Differential-Innenband-Kuppling Oder Bremse mit Verketteten Baendern), P. Kaeppler. Werkstattstechnik (Berlin), vol. 22, no. 15, Aug. 1, 1928, pp. 435–436, 5 figs. Details of patented Kaeppler coupling, its application in construction of internal bands expanding by centrifugal force; results of tests.

BRONZE

Hardness Testing. The Hardness Value for Standard Tin Bronzes, Red Brass Alloys, and Lead-Tin Bronzes in Cast State (Zur Kenntnis der Haertwerte der genormten Zinn-Bronzen, Rotguss-Legierungen und Blei-Zinn-Bronzen in gegossenem Zustande), W. Claus, H. Goeke and F. Goederitz. Giesserei (Duesseldorf), vol. 15, no. 31, Aug. 3, 1928, pp. 763–772, 19 figs. Results of Brinell hardness testing; regulations for different alloys.

High-Strength. Notes on High-Strength Bronzes (Notes sur les bronzes à hautes résistances), Duranton. Fonderie Moderne (Paris), vol. 22, Aug. 10, 1928, pp. 301–302. Composition of bronzes used in France; 10 kinds of ordinary and 4 kinds of high-strength bronzes; aluminum bronzes of high strength.

C

CABLEWAYS

Lumber Transporter. Mammoth Tramway to Span Western Canyon. Gen Elec. Rev., vol. 31, no. 9, Sept. 1928, p. 475. Recently erected by Michigan-California Lumber Co. at Camino, Calif.; single tram carrier carries rail car loaded with maximum of 24,000 lb. of sawed lumber; distance between terminals is approximately 2700 ft.; maximum speed of operation will be 1800 ft. per min.; four steel cables, each 2 in. in diam. support tram carrier which runs on 32 wheels; traction rope endless and one inch in diameter.

CASE HARDENING

Carburizing Compounds. Carburizing and Case Hardening. Heat Treating and Forging, vol. 14, no. 7, July 1928, pp. 757–761, 1 fig. Carburizing compounds used and containers employed with proper directions given for packing parts; cyanide and gas carburizing; lead and furnace treatments. From Driver-Harris Co. booklet on Nichrome Castings.

CAST IRON

"Gunite." "Gunite"—Its Properties and Applications. Machy. (N. Y.) vol. 35, no. 1, Sept. 1928, pp. 61–62, 3 figs. New metal known as Gunite recently announced by Gunite Corp. of Rockford, Ill., is described; metal does not exhibit ductility of malleable iron or steel and shrinkage is less than one part in one thousand as result of heat treatment; micrograph compared with those of cast iron and semi-steel; no tendency to form hard outer skin; freedom from internal strains; ability to resist wear under friction; tests made at Armour Institute of Technology.

Pearlitic. High-Grade Cast Iron (Hochwertiges Gusseisen), H. Jungbluth. Maschinenbau (Berlin), vol. 7, no. 16, Aug. 16, 1928, pp. 766–770, 3 figs. Compilation based on recent papers in German and in English, by Piwowarsky, Kerpely, Young, and others; improvement of cast iron by addition of other metals, production of pearlitic mass, reduction in graphite content, etc.

CHROMIUM-NICKEL ALLOYS

High-Temperature. Laboratory Experiments on High-Temperature Resistance Alloys, C. J. Smithells, S. V. Williams and J. W. Avery. Inst. of Metals—advance paper (Lond.), no. 466, for mtg., Sept. 4–7, 1928, 22 pp., 17 figs. Nickel-chromium alloys containing 10 to 60 per cent of chromium and ternary alloys containing tungsten and molybdenum were subjected, together with commercial nickel-chromium alloys, to new forms of test for resistance to oxidation and sag at high temperatures; presence of small amounts of impurities has marked effect; commercial alloys are inferor to experimental alloys for this reason.

COAL

Carbonization, Low-Temperature. The "Plassmann" Process of Low Temperature Carbonization, D. Brownlie. Gas Age-Rec., vol. 62, no. 7, Aug. 18, 1928, pp. 196–198, 3 figs. Description of process consisting of mechanically continuous retort for carbonization at not over 1110 degrees fahr. of bituminous coal dust and smalls; plastic change is submitted to both mechanical compression and natural internal compression and hard, dense, smokeless fuel in large sized pieces containing about 8 to 12 per cent volatile matter.

COAL HANDLING

Belt Conveyors. Caterpillar Coal Face Conveyor, G. F. Zimmer. Indus. Mgmt. (Lond.), vol. 15, no. 8, Aug. 1928, pp. 264–265, 4 figs. Description of conveyor with caterpillar drive designed to overcome objections to belt conveyor of ordinary type; necessary friction is obtained by snubbing idlers; motive power is furnished by electric or compressed air motors.

Grab Buckets. New Type of Segmental Grabs (Ein neuer Segmentgreifer), C. Huetter. Gas und Wasserfach (Munich), vol. 71, no. 30, July 28, 1928, pp. 734–735, 2 figs. Description of grab buckets consisting of six segments of hyperbolic profile, 2 cu. m. or more in capacity, 1 to 5 tons in weight, 75 to 100 tons of rock or coal per hour; especially recommended for handling of coal, coke, etc.

Iron and Steel Plants. Coal and Ash Handling fo. Steel Plants, H. S. Ford. Blast Furnace and Steel Plant, vol. 16, no. 8, Aug. 1928, pp. 1070–1071 and 1075, 2 figs. Simplicity and durability of devices that make use of steel cable are brought out; horizontal transportation problems easily solved; skip hoist; ability of cable drag scraper to cover area is obtained by use of tail block car.

Shaker-Conveyor Motors. The Flottmann Universal Shaker-Conveyor Motor and Its Performance. Bohrhammer (Herne), vol. 8, no. 80, June 1928 (English edition), pp. 102–107, 8 figs. Article describes motor driven by compressed air and used to actuate shaker conveyor for handling coal; comparative tests on coal handling by means of motors of various kinds; air cost per foot-ton for conveying by shaker conveyors and different makes of motor.

COOLING TOWERS

Concrete, Hyperbolic. The Hyperbolic Reinforced-Concrete Cooling Tower, J. H. D. Blanke. Nat. Engr., vol. 32, no. 5, May 1928, pp. 209–213, 5 figs. Types of cooling towers; facts of great importance in design and construction; van Iterson, director of power plants of various Dutch State mines has designed cooling tower based on entirely different principles; it is of hyperbolic shape and reinforced-concrete construction.

COPPER-MAGNESIUM ALLOYS

Tests. The Copper-Magnesium Alloys, W. R. D. Jones. Inst. of Metals.—advance paper (Lond.), no. 469, for mtg. Sept. 4–7, 1928, 11 pp., 5 figs. Paper deals with notched-bar impact tests on forged and heat-treated alloys; there is no advantage in adding more than 2 per cent of copper to magnesium; alloys containing more than 5 per cent are brittle; on exposure to cold, toughness has been decreased; simple heat treatment does not improve notched-bar impact values to any appreciable extent; effect of forging on microstructure has been to break down eutectic network, resulting in improvement of mechanical properties.

COPPER-NICKEL CASTINGS

Specifications. Proposed Master Specification for Copper-Nickel Alloy Castings. Foundry, vol. 56, nos. 15 and 16, Aug. 1 and 15, 1928, supp. sheets, nos. 727, 728, and 729, 1 fig. Aug.: United States Government general specification for metals, Federal Specifications Board Specification No. 339, in effect on date of invitation for bids, forms part of this specification; general and detail requirements of material, and method of inspection and tests given. Aug. 15: Inspection; packing and marking of shipment.

COTTON FABRICS

Analysis, Alignment Charts for. Ingenious New Chart Devised for Simplifying the Solution of Cotton Cloth Analysis Problems, A. S. Mark. Textile World, vol. 74, no. 6, Aug. 11, 1928, pp. 38–39, 1 fig. Suggestions regarding application of graphical methods to textile industry; presents graphical method which is very easy to follow and which can give accurate results in solution of various textile problems; finding weight of cloth; pounds of yarn per yard; counts of warp and filling; how chart was made.

CRANES

Runways. Reinforcing Craneways in a Big Shop. Am. Mach., vol. 69, no. 10, Sept. 6, 1928, pp. 398–400, 6 figs. Describes work in Schenectady plant of General Electric Co., where new columns were placed to support runway for new 130-ton crane, while leaving old columns to carry roof trusses as before; reinforcements were made by welding on reinforcing plates by means of electric arc; necessary to provide new crane-runway supports; foundations for columns, supporting 80-ft. spans of heavy girder are 14 ft. wide instead of 8 ft.; reinforcements are six 24-in. I-beams running lengthwise in bottom slab and four 20-in. crosswise in upper slab.

CUPOLAS

Charging. A New System of Cupola Charging. West. Machy. World, vol. 19, no. 8, Aug. 1928, pp. 365–367, 5 figs. New system, called Whiting Wishbone system, based on use of special dump buckets for holding coke and iron is described; original method of dumping bucket; system applicable to crane or monorail chargers; bucket more adaptable to small cupolas than cone bottom.

CYLINDERS

Metal, Stresses in. Internal Stresses in Metallic Cylinders (Sur la détermination des efforts internes dans les cylindres circulaires métalliques), Portevin. Académie des Sciences—Comptes Rendus (Paris), vol. 186, no. 14, Apr. 2, 1928, pp. 939–941, 1 fig. Internal stresses of metallic cylinders have been determined by measuring deformation when successive layers are removed; Heyn and Bauer have given mathematical expression for reducing observations which has been correct by Mesnager; in this paper graphical charts of stresses in actual experimental cylinders are shown, using two methods; general distribution is very similar.

D

DESUPERHEATERS

Saturators and. Desuperheaters and Steam Saturators (Desurchauffeurs et saturateurs de vapeur), P. Coulon. Société Alsacienne de Constructions Mécaniques—Bul. (Belfort, France), vol. 6, no. 23, July 1928, pp. 80–84, 4 figs. Describes closed pressure vessels designed to put moisture into dry or superheated steam for industrial uses which require wet steam; one vessel of 6 tons per hr. capacity, other of 16 tons per hr.

DIE CASTING

Aluminum Alloys. Properties and Production of Aluminum Alloy Die-Castings, S. L. Archbutt, J. D. Grogan and J. W. Jenkin. Inst. of Metals—advance paper (Lond.), no. 477, for mtg. Sept. 4–7, 1928, 19 pp., 19 figs. Investigation of die castings made in permanent metal molds under gravity feed, i.e., without application of external pressure and hot-shortness of aluminum die-casting alloys; two types of casting were investigated: (1) shouldered test piece of circular section suitable for testing direct without machining; (2) hollow tubular casting requiring use of cores in molding; to overcome defects due to air locks, shrinkage, etc., careful control of working conditions was necessary.

Copper Alloys. Die-Casting of Copper-Rich Alloys, R. Genders, R. C. Reader and V. T. S. Foster. Inst. of Metals—advance paper (Lond.), no. 475, for mtg. Sept. 4–7, 1928, 32 pp., 6 figs. Exploratory examination of wide range of alloys in form of chill-cast bars and die-cast test pieces has indicated that variety of alloys exist suitable for die casting and offering mechanical properties to meet varying requirements; aluminum brasses have advantages in their range of properties, high proof stress, slow rate of attach on mold and core materials, and cheapness.

Zinc Alloys for. Die-Casting Alloys of Low Melting Point, T. F. Russell, W. E. Goodrich, W. Cross, and N. P. Allen. Inst. of Metals—Advance Paper (Lond.), no. 473, for mtg. Sept. 4–7, 1928, 15 pp., 4 figs. Sixteen zinc-base alloys, having either copper and tin, or copper and aluminum, and in some cases with further additions of either nickel, cadmium, lead, or magnesium were examined microscopically and thermally, and their densities determined; effects of strength and on permanency of dimensions, after atmospheric aging, were investigated and large number of tests of so-called "accelerated aging" type were made.

DIESEL ENGINES

Air Compressors for. Air Compressors for Auxiliary Power in Starting Diesel Engines. Power, vol. 68, no. 8, Aug. 21, 1928, p. 329, 4 figs. Complete line of Diesel and high-pressure auxiliary air compressors, designed for providing starting air, emergency injection air, and charging air bottles has been brought out by Rix Co.; units are entirely inclosed and provided with splash lubrication.

Compressorless, Fuel Pumps for. Fuel Pumps of Compressorless Diesel Engine (Brennstoffpumpen kompressorloser Dieselmotoren), O. Holm. Archiv fuer Waermewirtschaft (Berlin), vol. 9, no. 8, Aug. 1928, pp. 258–261, 24 figs. Author points out difficulties which have existed so far in production of efficient fuel pumps for compressorless engines; discusses causes of trouble and means for their elimination; advantages and disadvantages of usual types and arrangement of valves, pump chambers, and packing.

Marine (Sulzer-Schelde). The Sulzer-Schelde Marine Engines (Sulzer-Schelde Scheepsdieselmotoren), F. C. Martzinger. Schip (Hague), vol. 10, no. 15, July 20, 1928, pp. 195–204, 22 figs. Characteristics and special merits of Dutch adaptation of Sulzer two-cycle and four-cycle marine Diesel engines, for use on Dutch four-screw motor liners.

DIESEL LOCOMOTIVES

Speed Changers for. Universal Transmission for Electric Locomotives, and Speed Changer Operated by Oil Under Pressure for Diesel Locomotives Constructed by the Société de Locomotives de Winterthur (Transmission universelle pour locomotives électriques et changement de vitesse actionné par huile sous pression pour locomotives Diesel, construits par la Société de Locomotives de Winterthur). Revue Générale des Chemins de Fer (Paris), vol. 47, no. 2, Aug. 1928, pp. 258–262, 6 figs. Description of transmission used on electric locomotive and geared speed reducer used on Diesel locomotives.

E

ECONOMIZERS

Design and Operation. What the Boiler Plant Engineer Should Know of Material, Design and Operation of Exhaust-Gas Feedwater Preheaters (Was der Dampfkessel-Ingenieur von dem Material, dem Bau und dem Betrebe der Abgas-Speisewasser-Verwaermer wissen muss), G. Frantz. Waerme (Berlin), vol. 51, no. 30, July 28, 1928, pp. 527–545, 18 figs. Notes on improvement of cast iron for use in economizer construction; smooth-tube and ribbed-tube economizers; ingot-steel economizers; regulation of feed; operation; damage to economizers and explosions; calculation and results of tests; statuary regulations.

ELECTRIC FURNACES

Hydrogen-Nitrogen Mixtures. The Application of Oxygen and Hydrogen to Industrial Operation, F. P. Wilson. Gen. Elec. Rev., vol. 31, no. 9, Sept. 1928, pp. 493–495, 1 fig. Brief description of some features that must be considered in using hydrogen and hydrogen-nitrogen mixtures in electric furnaces; produce non-oxidizing or reducing atmosphere in furnace; factors that are involved in combustion, explosion, and detonation.

Steel-Making. Electric Furnaces, Brown-Boveri System with Hydraulic Regulation of Electrodes (Fours électriques système Brown-Boveri à reglage électro-hydraulique des électrodes), E. de Mulinen. Génie Civil (Paris), vol. 93, no. 6, Aug. 11, 1928, pp. 143–145, 5 figs. Describes electric furnace of 20 tons capacity installed at Aosta; has 3 electrodes of 600 mm. diam. for 15,000-amp. current; how electrodes are regulated.

ELECTRIC LOCOMOTIVES

Germany. The Bergmann 2-C-2 Locomotive With a Single Motor (La locomotora Bergmann 2-C-2 de un solo motor). Ingenieria, y. Construction (Madrid), vol. 6, no. 67, July 1928, pp. 369–370, 3 figs. Brief description and principal specification data on electric locomotive with one 3200-hp. motor using alternating current at 15,000 volts.

Switching. Electric Shunting Locomotives. Engineer (Lond.), vol. 146, no. 3788, Aug. 17, 1928, pp. 182–183, 3 figs. Two locomotives built by Metropolitan-Vickers Electrical Co. for Broken Hill Proprietary Co., New South Wales, to meet special requirements of quarry service; locomotives are of swivelled double-truck central cab type; each truck has two axle-mounted motors connected permanently in series for service on 600-volt supply, and two pairs of motors are arranged for series parallel control.

ELECTRIC WELDING

Arc-Welding Steel Structures. Arc-Welding Steel Structures and Machine Parts, A. M. Candy. Machy. (N. Y.), vol. 35, no. 1, Sept. 1928, pp. 51–52, 7 figs. Examples of arc-welding and cutting processes in one of Westinghouse plants for both adding to steel structures and constructing machine parts.

Resistance Welders. Resistance Welders as Manufacturing Tools. Engineering (Lond.), vol. 126, no. 3265, Aug. 10, 1928, pp. 158–161, 16 figs. Particulars of some articles made in large scale by resistance welding, as practiced by British Insulated Cables, Ltd.; details of machine on which work has been carried out with success.

ELEVATORS

Electric. Vertical Transportation for Office Buildings, H. H. Dahlman. West. Soc. Engrs.—Jl., vol. 33, no. 7, July 1928, pp. 356–363. To obtain criterion of elevator service requires constant observation of many types and localities of buildings, of different kinds of occupancy; traces through years changes in use of buildings, and variations in realty conditions; elevator grouping; platform proportions; door entrances; hangers; door operators; signals; elevator velocity; traffic flow; intervals; calculating schedules.

F

FLOW METERS

Steam. Correction of the Steam-Flow Meter for Change in Size of Orifice, H. Weber. Power. vol. 68, no. 9, Aug. 28, 1928, p. 362, 4 figs. Author shows method by which meter can easily be corrected.

FORGINGS

Brass, Heat Treatment of. The Heat Treatment of Drop Forged Brass, R. Hinzmann. Fuels and Furnaces, vol. 6, no. 8, Aug. 1928, pp. 1047–1050, and 1069–1070, 16 figs. Investigation refers to brass alloy containing 50 per cent copper, 2 per cent lead, and balance zinc; quality and mechanical properties of finished product depend very much on heat treatment to which alloy has been subjected under extrusion and before drop forging. Translated from Zeit. fuer Metallkunde.

FORGINGS

Steel, Heat Treatment of. Determination of the Heating Time for Forgings. Fuels and Furnaces, vol. 6, no. 8, Aug. 1928, pp. 1081–1082, 2 figs. Heating time of forging can be determined as function of its surface and its volume; in order to make practical use of equation, graphic chart called furnace chart, developed by H. Freund, makes it possible to determine rapidly heating time for forgings. Abstract translated from Maschinenbau.

Heat Treating Ball Races by Machinery, L. A. Lanning. Am. Mach., vol. 69, no. 8, Aug. 23, 1928, pp. 229–302, 6 figs. Seventy-five tons of ball-race forgings are handled daily through heat-treatment department of New Departure Mfg. Co., incidental to manufacture; most of it by automatic materials-handling equipment; description of processes, furnaces and materials-handling methods is given.

FOUNDRY PRACTICE

Oxyacetylene Welding. Oxy-Acetylene Welding in the Foundry, G. F. Wieser. Acetylene Jl., vol. 30, no. 2, Aug. 1928, pp. 59–62. Welding torch is important factor in assisting up-to-date foundryman to keep costs down, to make deliveries of sound well-finished castings; oxy-acetylene-welding process possesses characteristics which make it peculiarly and increasingly applicable in non-ferrous, gray-iron and steel foundries; defects in steel castings; shows important part which oxyacetylene welding plays in enabling foundryman to meet customer's specifications. Paper read before Welding Conference.

FURNACES, ANNEALING

Normalizing in. Furnaces and Methods in Normalizing. Heat Treating and Forging, vol. 14, no. 8, Aug. 1928, pp. 915 and 917. Process in normalizing is to increase heat slowly and uniformly until desired temperature is attained; after "soaking" piece sufficiently, it is allowed to cool freely in air, uniformity of temperature is imperative; annealing furnaces may be used for normalizing except in treatment of sheet steel where continuous furnace is generally used; special alloys necessary for furnace parts in order to withstand temperature; gas more satisfactory than fuel since it can be regulated more precisely.

FURNACES, FORGING

Gas Firing. Gas-Fired Forges at McCormick Works, J. B. Nealey. Heat Treating and Forging, vol. 14, no. 8, Aug. 1928, pp. 908–909, 3 figs. Description of new furnaces and burners at McCormick plant of International Harvester Co.; individual furnaces are mounted on standards constructed of pipe with cross-members for stiffening legs; there is clearance of 12 in. between floor and cross-members so that furnaces may be handled with standard elevating trucks; regulation of flame and precautions against overheating.

FURNACES, HEAT-TREATING

Types. Furnaces for Various Heat Treatments, P. C. Osterman and E. C. Cook. Heat Treating and Forging, vol. 14, nos. 7 and 8, July and Aug. 1928, pp. 781–784 and 903–907, 14 figs. July: Oven semi-muffle furnace is described in connection with treatment of high-speed steel tools; vertical cylindrical type furnaces and salt baths adaptable for certain purposes; electric and gas-fired furnaces compared. Aug.: Case-hardening problems are reviewed and number of installations are described.

G

GAGES

Krupp Mikrotast. Krupp Mikrotast Gage. Machy. (Lond.), vol. 32, no. 823, July 19, 1928, pp. 510–513, 11 figs. Description of gage developed by F. Krupp A.-G., Essen, which consists of two parts, Mikrotast proper which may be used alone, and adapters to suit work to be gaged; Mikrotast can be supplied and with wide range of scale graduations reading in both millimeters and inches, and measurements can be taken to 0.001 mm. or 0.00004 in.; pointer actuating mechanism; gaging cylindrical surfaces; special applications of saddle gage; internal gaging; thread gaging.

GARAGES

Mechanical Handling in. Garage Has Mechanical Handling for Cars. Eng. News-Rec., vol. 101, no. 10, Sept. 6, 1928, pp. 359–361, 3 figs. Twenty-two story 66 by 88-ft. garage in 41-story Pure Oil Building downtown business district of Chicago, which has storage capacity for 572 cars, and in which cars are moved vertically by elevators and horizontally by transfer tables, without use of their own power, is new development toward solving parking problems in con-

gested districts; also providing parking accommodation for tenants in office buildings.

GAS ENGINES

Heat Losses in. Losses in Exhaust of Large Gas Engines (Verluste im Auspuff von Grossgas motoren), J. R. Solt. Stahl und Eisen (Duesseldorf), vol. 48, no. 33, Aug. 16, 1928, pp. 1132–1133, 2 figs. Thermodynamic investigations of large gas engines are recommended to prevent construction of uneconomical types; in older types of 4-stroke engines, lack of uniform mixture of charge is often due to imperfect working of gas valves.

GASES

High-Pressure Research. High Pressure Gas Research at the University of Illinois, N. W. Krase. Chem. and Met. Eng., vol. 35, no. 8, Aug. 1928, pp. 463–465, 4 figs. Description of installation of pressure equipment at University of Illinois; in range of pressures from atmospheric to about 4000 lb. per sq. in., many interesting problems arise and much work can profitably be done with relatively simple and inexpensive equipment.

GEARS

Design. The Arc Gear Tooth System, A. Fisher. Machy. (Lond.), vol. 32, no 826, Aug. 9, 1928, pp. 595–598, 6 figs. Tooth-shape system described in which tooth curves of one gear in pair consists of circular arc, those of other being conjugate; as far as tooth contact is concerned, arc tooth appears to be slightly superior to involute; Brown and Sharpe standard involute tooth not involute tooth at all but nearly approximates arc tooth; effect of center distance maladjustment may not be seriously detrimental if small.

Non-Metallic, Horsepower of. Horsepower of Non-Metallic Spur Gears. Machy. (N. Y.), vol. 35, no. 1, Sept. 1928, suppl. sheet no. 137. Method of computing horsepower of spur gears composed of laminated phenolic materials or rawhide, as recommended practice of Am. Gear Mfrs.' Assn.; table of safe working stresses for different speeds.

Tooth Modification. Hob Corrections for Gear Tooth Modifications, J. A. Hall. Am. Mach., vol. 69, no. 10, Sept. 6, 1928, pp. 379–382, 4 figs. With increasing use of tip relief on gear teeth, it is necessary to decide not only to what extent tooth curve should be modified, but also what form of hob or other cutting tool is required to generate desired shape; table gives comparative data on typical gears produced by hobs modified according to various systems; equations and curves are given for determining tip relief, radial relief and entrance angle on any chosen size of gear when cut with hob of known shape. Paper presented before Am. Gear Mfrs. Assn.

GRINDING

Precision. Precision Grinding of Small Parts, F. W. Curtis. Am. Mach., vol. 69, no. 9, Aug. 30, 1928, pp. 359–361, 8 figs. Notes on grinding of small parts used in construction of Filmo moving-picture equipment made by Bell & Howell Co.; grinding equipment consists of many small machines, some of which are of bench type, equipped with well-devised operating features; among operations performed are surface, cylindrical and internal grinding.

H

HEAT TRANSMISSION

Pipes. Heat Transfer Between Flowing Liquid and Enclosing Pipe Shell (Waermeuebergang stroemender Fluessigkeit in Rohren), L. Schiller and T. Burbach. V.D.I. Zeit (Berlin), vol. 72, no. 34, Aug. 25, 1928, pp. 1195–1196, 2 figs. Report from laboratory of applied mechanics and thermodynamics of University of Leipzig; review of Reynolds, Prandtl, and other theories of heat transfer between liquid and pipe; author's new special formula for liquids corresponding to Nusselt formula for gas flow; authors check experiments with hot water flowing in pipes.

Note on Heat Transmission in Pipes (Bermerkung ueber den Waermeuebergang im Rohr), L. Prandtl. Physikalische Zeit. (Leipzig), vol. 29, no. 14, July 15, 1928, pp. 487–489. Theoretical, mathematical elaboration of older formulas; takes account of phenomena of turbulent flow of liquid in pipes.

Walls. Thermal Phenomena in Walls of any Form (Waerme und Temperaturverlauf in Waenden von beliebiger Form), K. Lachmann. V.D.I. Zeit. (Berlin), vol. 72, no. 32, Aug. 11, 1928, pp. 1127–1128, 6 figs. Theoretical, mathematical discussion deriving formulas and graphical chart for investigation of heat flow in walls of any shape.

HYDROELECTRIC DEVELOPMENTS

British Columbia. Water-Power Resources of British Columbia. Elec. World, vol. 92, no. 9, Sept. 1, 1928, p. 409, 1 fig. Water-power resources are estimated at 1,930,000 hp. minimum and 5,100,000 hp. for six months of which 460,562 hp. has already been developed; principal central-station systems in province are those supplying Vancouver, Victoria, and Nelson districts.

Conowingo, Md. The Conowingo Hydroelectric Development on the Susquehanna River, A. Wilson. Am. Inst. Elec. Engrs.—Jl., vol. 47, no. 9, Sept. 1928, pp. 655–657. Unusual features of design and construction of dam, power station, and hydraulic equipment, together with general description of entire project are described.

HYDRAULIC TURBINES

Testing. Pilot-Valve Control Applied to Water-Wheel Governor for Testing Operations, E. B. Strowger. Power, vol. 68, no. 6, Aug. 7, 1928, pp. 230–231, 3 figs. Gibson method of testing hydroelectric power plants requires a means of gradually stopping flow in penstock to produce pressure-time diagram record by Gibson apparatus; this is accomplished by closing turbine gates by means of governor.

I

ICE PLANTS

Philadelphia. Tacony Plant of Kensington Hygeia Ice Co., Philadelphia, Pa. Ice and Refrig., vol. 75, no. 2, Aug. 1928, pp. 93–95, 6 figs. Group system with new type automatically regulated evaporating coils installed in enlarged substation provides convenience in supervision by engineer and economy in operation; small automatic plant furnished with original substation retained for use in winter allowing shutdown of main plant; air-agitating system; auxiliary tanks on roof.

INDUSTRIAL LIGHTING

Vibrations Effect. Vibration as Related to Industrial Lighting, A. J. Thompson. Iron and Steel Engr., vol. 5, no. 8, Aug. 1928, pp. 390–391. Vibration presents very real problem in industrial lighting due to extremely delicate structure of light-producing filament in incandescent lamp; there are six factors involved, viz.: wave length, intensity, frequency, rhythm, direction, and character of vibrating medium, each of which has its own peculiar influence or effect upon lamp filament; it becomes essential to safeguard filament with respect to each of these factors.

INDUSTRIAL MANAGEMENT

[See PRODUCTION CONTROL; TIME STUDY.]

INTERNAL-COMBUSTION ENGINES

Exhaust-Gas Analysis. Exhaust Gas Analysis Calculations, E. H. Lockwood and O. C. Bridgeman. Soc. Automotive Engrs.—Jl., vol. 23, no. 3, Sept. 1928, pp. 314–316, 1 fig. E. H. Lockwood's formula and diagrams on exhaust-gas analysis and resulting air-fuel ratios are given with comment by O. C. Bridgeman; validity of relations questioned.

Interpretation of Exhaust-Gas Analysis, O. C. Bridgeman. Soc. Automotive Engrs.—Jl., vol. 23, no. 3, Sept. 1928, pp. 313–314. Comment on previous article by C. C. Minter printed in January issue; great need for extensive study of chemical reactions that occur in cylinder; such knowledge attempts to draw quantitative conclusions about these reactions from analysis of gas drawn from exhaust manifold, appear to be futile; difficulties in applying theory of errors.

[See also AIRPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; GAS ENGINES; OIL ENGINES.]

IRON CASTINGS

Gray. Way to Improve Gray-Iron Castings, R. Moldenke. Iron and Steel of Can. (Gardenvale, Que.), vol. 11, no. 8, Aug. 1928, pp. 240–242. Most important advances made recently by scientists rather than men in active operation of foundries; iron melted under conditions of superheat, far beyond ranges of ordinary practice, may give castings perhaps twice as strong; superheated metal held before pouring; composition of high-test irons. Abstracts of paper presented at European Foundrymen's Congress, Barcelona, Spain.

IRON FOUNDRIES

Casting Practice. Casting Technique (Die Giesstechnik fuer Gusseisen), J. Petin. Giesserei (Duesseldorf), vol. 15, no. 31, Aug. 3, 1928, pp. 749–757, 15 figs. Theory of casting technique is developed, based on schematic plan; results of tests to explain technique in casting of iron drums and hand ladles; from results obtained it is possible to plot diagrams for every size of ladle to determine proper gate diameter.

Gray-Iron. Completes New Foundry for Compressor and Engine Gray Iron Castings. Iron Age, vol. 122, no. 8, Aug. 23, 1928, pp. 461–462, 2 figs. Chicago Pneumatic Tool Co. has completed new foundry at Franklin, Pa.; building is 130 ft. wide and 220 ft. long; buildings and foundry equipment represents investment of more than $400,000; 225 men will be employed; equipment includes two cupolas, one of 16 and one of 8 tons per hour capacity.

L

LOCOMOTIVES

Design. British Influence on American Locomotive Design. Modern Transport (Lond.), vol. 9, no. 491, Aug. 11, 1928, pp. 3–4, 7 figs. New Pacific-type locomotive built at Mt. Clare shops of Baltimore and Ohio Railroad, design of which is said to be strongly influenced by British design.

Diesel. See DIESEL LOCOMOTIVES.

Electric. See ELECTRIC LOCOMOTIVES.

Frames. Graphical Analysis of Rigid Beams on Elastic Supports (Zeichnerische Untersuchungen fuer den starren Traeger auf Elastischen Stuetzen) E. Pawelka. Organ fuer die Fortschritte des Eisenbahnwesens (Berlin), vol. 83, no. 15, Aug. 1, 1928, pp. 289–292, 8 figs. Author develops graphical method of analysis of stresses in beam members of locomotive frames resting on springs.

High-Pressure, Switzerland. High-Pressure Locomotives of the Swiss Locomotive Works of Winterthur (Hochdrucklokomotive 60 Atm. der Schweizerischen Lokomotiv- und Maschinenfabrik Winterthur), H. Brown. Zeit. des Oesterr. Ingenieur u. Architekten-Vereines (Vienna), vol. 80, no. 31/32, Aug. 3, 1928, pp. 279–285, 15 figs. Details of locomotives of 60-atmos. pressure, having 3 cylinders placed on special platform in front of boiler; steam-entropy diagrams; details of superheater, etc.; turbine vs. displacement engine drive; comparison of performance with that of 12-atmosphere twin-cylinder locomotive of type B 3/4.

Oil-Electric. A 660-Hp., 87-Ton Oil-Electric Switcher for the Long Island Railroad, J. H. Harvey. Ry. and Locomotive Eng., vol. 41, no. 6, June 1928, pp. 162–165, 5 figs. Locomotive consists of two units each complete with oil engine, generator, motors, control and auxiliary equipment; two units are coupled together for normal multiple operation; simultaneous control of oil-engine speeds and electric connections on both units is effected by means of single control lever on master controller; description of oil engine; main and auxiliary generators, traction motors, air-brake equipment, control apparatus, and fuel tanks, and cooling system.

New York Central Oil-Electric Freight Locomotive, S. T. Dodd. Ry. Elec. Engr., vol. 19, no. 8, Aug. 1928, pp. 253–255, 5 figs. Generator is provided with small amount of differential series field, self-excited shunt field and separately excited field; first oil-electric locomotive to be built particularly for road service; principal dimensions and data relating to this locomotive; cab and running gear; oil engine; electric equipment.

Pulverized-Coal. The AEG Pulverized Fuel Locomotive, W. Kleinow. Fuel (Lond.), vol. 7, no. 8, Aug. 1928, pp. 345–363, 23 figs. Development of use of pulverized fuel; development of A.E.G. system of pulverized-fuel combustion for locomotives; A.E.G. pulverized-fuel tender; trial of locomotive on road.

Steam-Turbine. The Super-High-Pressure Turbine Locomotive of the J. A. Maffei A. G. Eng. Progress (Berlin), vol. 9, no. 8, Aug. 1928, pp. 218–219. German State Railways Co. have placed order with Locomotive Works of J. A. Maffei, of Munich, for locomotive with super-high-pressure boiler and turbine drive; locomotive will be express train engine of 4-6-2 type, of 2500 hp. maximum capacity and will have maximum speed of 110 km., 68 m. per hour; boiler as Benson type.

Three-Cylinder. Some Experimental Results From a Three-Cylinder Compound Locomotive, L. H. Fry. Instn. Mech. Engrs.—Proc. (Lond.), no. 4, 1927, pp. 923–954 and (discussion) 955–1024, 30 figs. Study, by means of experimental data, of some phases of cylinder action of 3-cylinder locomotive using boiler pressure of 350

lb. per sq. in.; locomotive built as experiment by Baldwin Locomotive Works in 1926 under serial no. 60,000; after thorough series of tests on Pennsylvania Railroad locomotive testing plant at Altoona, it has been tried in road service on number of important railroads in United States with very satisfactory results.

Wheel Loading. Dynamic Loading on Locomotive Wheels, G. Lomonossoff. Engineer (Lond.), vol. 146, nos. 3784 and 3785, July 20 and 27, 1928, pp. 58–59 and 83–85, 4 figs. Actual balance weights attached to wheels of locomotive can be replaced in theory by two balance weights: those which counteract centrifugal forces of revolving parts, and those, horizontal component of which counteracts portion of reciprocating parts; results of experimental research show that greatest oscillations of springs reach in particular cases values of 25 mm., and always occur on coupled driving wheels.

M

MACHINE TOOLS

Ball Bearings. Ball Bearings for Main Spindles, H. W. Holdsworth. Machy. (N. Y.), vol. 35, no. 1, Sept. 1928, pp. 11–16, 8 figs. Application of ball bearings to machine tools of different types and spindle arrangements; deformation and contact area of balls; enormous crushing strength of balls; necessity for proper static load; spindles requiring three bearings; ball bearings for milling machine and small high-speed spindles; grinding-machine installation.

Electric Drive. Electric Drivers for Machine Tools, A. Fox and A. J. Whitcomb. Machy. (N. Y.), vol. 35, no. 1, Sept. 1928, pp. 33–36, 5 figs. Application of motor drives to drilling and grinding machines, presses, punches, shears, bulldozers, and bending and straightening rolls; tables of sizes given.

Speed Standardization. Standardization of Speed in Machine-Tool Design (Einzelheiten Ueber die Drehzahlnormung im Werkzeugmaschinenbau), R. Panzer. Werkstattstechnik (Berlin), vol. 22, no. 15, Aug. 1, 1928, pp. 425–433, 19 figs. After elaborate discussion, author develops series of r.p.m. numbers of machine tools based on DIN series of preferred numbers.

MACHINERY

Power Requirements. Power Required to Drive Machinery, J. W. Brassington. Nat. Engr., vol. 32, no. 4, Apr. 1928, pp. 155–158, 3 figs. Fundamental principles involved in calculation of power required to drive machinery and their application to practical problems; hints on selection of lubricants and their application; facts and deduction therefrom given have been used by writer to determine or control amount of power used to drive machinery either in single units or in groups; factors determining power requirements; example of calculation; design of journals and bearings.

Torsion Resistance. Resisting Torsional Strains in Machinery Bases. Am. Mach., vol. 69, no. 9, Aug. 30, 1928, p. 342, 4 figs. Illustrations of use of butt-welded tubes for resisting effects of torsion; examples of tests carried out by Lincoln Electric Co. on tubular cross-members for base on gasoline-driven hoist.

MANGANESE STEEL

Manufacture by Electric Process. Making Electric Manganese Steel, J. H. Hruska. Iron Age, vol. 122, no. 8, Aug. 23, 1928, pp. 455–456, 2 figs. Homogeneous metal, practically negligible losses of manganese, few non-metallic and gaseous inclusions and possibility of hotter steel, are advantages of making manganese steel in basic electric furnace; production costs are higher, however, as compared with open-hearth process.

MATERIALS HANDLING

Grab Buckets. Grabs, E. G. Fiegehen. Engineering (Lond.), vol. 126, no. 3267, Aug. 24, 1928, pp. 224–225, 4 figs. Grabs for transporters and telphers; automatic coiling drums.

Iron and Steel Plants. Clamshell Buckets in the Steel Industry, E. L. Harrington. Blast Furnace and Steel Plant, vol. 16, no. 8, Aug. 1928, pp. 1076 and 1075, 1 fig. Materials-handling problems in steel plant, which require use of clamshell buckets, are taken up; construction features necessary to meet severe conditions of steel plant service are reviewed; bucket weight important to efficient operation.

Sack Pilers. Portable Double-Arm Sack Piler. Engineering (Lond.), vol. 126, no. 3265, Aug. 10, 1928, pp. 182–183, 4 figs. In this piler, constructed by R. Boby, Ltd., short arm is fixed, but long arm can be raised to as high an inclination as 45 deg., or lowered to horizontal; conveyor apron hoists at rate of 50 ft. per min., and has capacity of 600 sacks per hour.

METAL CUTTING

Temperature Effects. Cutting Tools Research Committee Report on Cutting Temperatures: Their Effect on Tools and on Materials Subjected to Work, E. G. Herbert. Instn. Mech. Engrs.—Proc. (Lond.), no. 4, 1927, pp. 863–892 and (discussion), 893–908, 21 figs. Heat-resisting properties of high-speed steel after subjection to primary and secondary hardening temperatures; hot hardness as means of determining predominant factor in tool efficiency; effect of cutting temperatures on work; steel and many other metals show marked decline in their capacity to work harden when within free cutting range; research toward finding source of work hardening changes in metals.

METALS

Fatigue. "Tired Steel," H. F. Moore. Engrs. and Eng., vol. 45, no. 8, Aug. 1928, pp. 171–178, 16 figs. Fundamental considerations in computing stresses in metal; metallographic microscope as aid in stress analysis; localized stresses; must be taken into account as well as widely distributed stresses; methods to use in testing metals for fatigue; design of specimens; effect in surface finish; utilization of results of tests. Abstract of address presented before Am. Soc. Steel Treating.

What is Fatigue (Was ist Ermuedung)? K. Laute and G. Sachs. V.D.I. Zeit. (Berlin), vol. 72, no. 34, Aug. 25, 1928, pp. 1188–1189, 2 figs. Report from government testing laboratory and Kaiser Wilhelm Institute for metal research at Berlin-Dahlem; review of fatigue of metals studied by Gough, Ludwik, Moore and Kommers, and others; new experiments by authors showing weakening effect of heat treatment on nickel bars subjected to vibrations repeated millions of times.

Heat Conductivity. Heat Conductivity of Metals as Factor in Heat Transfer, R. Worthington. Chem. and Met. Eng., vol. 35, no. 8, Aug. 1928, pp. 481–482. Phrases, heat transfer and heat conductivity, are applied to two distinct physical characteristics of flow of heat; although heat conductivity of metals is seldom consideration in choice of materials of construction for heat-exchange apparatus, it is necessary to appreciate that metals differ in efficiency with which they transmit heat according to their susceptibility to chemical attach and to physical characteristics of products of attach; examples of effect of surface condition of metal on heat-transfer rates.

Notched-Bar Tests. The Fracture of Notched Tensile Test Pieces (Der Bruch gekerbter Zugproben), W. Kuntze. Archiv. fuer das Eisenhuettenwesen (Duesseldorf), vol. 2, no. 2, Aug. 1928, pp. 109–117, 11 figs. Influence of shape and depth of notched on fracture in tensile test piece; definition of fracture resistance, its determination and its relation to stretching, drawing, and heat treatment; fatigue due to deformation.

Wear Testing. The Wear of Metals and Its Determination. Engineering (Lond.), vol. 126, no. 3267, Aug. 24, 1928, p. 237. Fact emerges that, just as it is difficult to reproduce in laboratory actual conditions which bring about corrosion, so is it difficult to reproduce artificially conditions which occasion wear; resistance to wear, owing partly to complex nature of physical characteristics involved and partly to wide range of service conditions which have bearing in question, must be determined, in many cases, by more or less tedious long-time full-scale tests.

MOTOR TRUCKS

Springs and Suspension. Vehicle Springs, J. H. Hyde. Times Trade and Eng. Supp. (Lond.), vol. 22, no. 527, Aug. 11, 1928, p. 546. Review of Engineering Research Special Report, No. 8, on measurement of displacement of vehicle springs under road-running conditions; three vehicles were used in test, 30-c.w.t. Army motor truck, three-ton Army motor truck before and after modification of rear-spring suspension had been made to imitate conditions of Hotchkiss drive, and two-seater high-speed automobile.

O

OIL ENGINES

Airless Injection, Testing. Experiments on Solid-Injection Engine, G. F. Mucklow. Automobile Engr. (Lond.), vol. 18, no. 244, Aug. 1928, pp. 306–310, 13 figs. Experiments carried out in engineering laboratories of University of Manchester on Crossley single-cylinder solid-injection heavy-oil engine Type 0123 which was so arranged that timing of fuel injection could be varied; normal injection timing of 348.5 deg. gives best results in case of particular engine under test.

Power Measurement. Exhaust Temperature as Load Index for Oil Engines, E. C. Magdeburger. Am. Soc. Naval Engrs.—Jl., vol. 40, no. 3, Aug. 1928, pp. 496–500, 1 fig. Proposal recently advanced by German engineer, V. Heidelberg, to use easily determinable exhaust temperature as load index deserves serious consideration; why knowledge of load conditions in cylinders of oil engine is important; reproduces results of 6-cylinder 4-cycle mechanical-injection engine with individual piston displacement equaling 1.074 cu. ft. See article by Heidelberg in V.D.I. Zeit. (Berlin), Dec. 24, 1927.

Power-Plants. An 11,700 B.H.P. Oil Engine for Power Station Work. Engineer (Lond.), vol. 146, no. 3786, Aug. 3, 1928, p. 128, 1 fig. This is claimed to be largest two-stroke double-acting oil engine in world to operate on airless-injection system; engines are being installed in a Berlin power plant.

OPEN-HEARTH FURNACES

Design. Improvements in Open Hearth Furnaces with Moll-Type Head (Neuerungen an Siemens-Martin-Oefen mit Moll-Kopf), K. H. Moll. Stahl u. Eisen (Duesseldorf), vol. 48, no. 34, Aug. 23, 1928, pp. 1160–1165, 6 figs. Report No. 146 of Steel Works Committee of Verein deutscher Eisenhuettenleute. Combustion process in hearth; arrangement of burner; description of air chamber with ante-chamber; checker arrangement of Moll-Rhenania brick; operating results; details of new valve.

P

PHOTOELASTICITY

Theory and Practice. Use of Oblique Double Refraction in Study of Strain Distribution in Stressed Bodies (Ueber die Anwendung der akzidentellen Doppelbrechung zum Studium der Spannungsverteilung in beanspruchten Koerpern), M. Waechtler. Physikalische Zeit. (Leipzig), vol. 29, no. 15, Aug. 1, 1928, pp. 497–534, 39 figs. Extensive review of theory and practice of photoelasticity; theoretical and practical studies by Coker, Filon, Mesnager, Koenig, Asch, author, and others; international bibliographic list of 102 references.

POWER PLANTS, HYDROELECTRIC

Automatic, Switzerland. Automatic Generating Plants Installed in Switzerland (Les usines génératrices à fonctionnement automatique installées en Suisse), J. Kloninger. Revue Générale de l' Electricité (Paris), vol. 24, no. 5, Aug. 4, 1928, pp. 189–195, 6 figs. Article describes some arrangements adopted for remote control and automatic operation of generating plants; treats of synchronous alternators at Goeschenen, advantages and starting peculiarities; plants at Ranconnière and Hofen are described; also d. c. plant at Davos.

California. Power House No. 2A on Big Creek in Operation. Elec. World, vol. 92, no. 9, Sept. 1, 1928, p. 425, 1 fig. Power House of Southern California Edison Co. Big Creek-San Joaquin River project has static head of 2419 ft., declared to be higher than that of any other hydroelectric plant of equal capacity in United States; energy is developed at 11,000 volts and transformed to 220,000 volts before being transmitted to central and southern California.

Gates. Roller and Sector Gates on Hydro Plants, O. Reed. Eng. News-Rec., vol. 101, no. 10, Sept. 6, 1928, pp. 346–349, 7 figs. General review of hydroelectric development in Norway; special problems; regulation of forebay ponds by sector and roller gates at Raanaasfos, Solbergfos, and Vamma; Raanaasfos dam spillway has capacity of 141,000 sec.-ft. and is regulated by two sector gates and one roller weir, 164 ft. long with regulating height of 12.3 ft.; reliability of these gates proved by thorough operating experience; electric heating of roller gates; objection to use of sector gates is wide masonry base which is required.

Ice Control. Electric Heating Protects Sluice Gates and Intakes Against Ice, J. H. D. Blanke. Nat. Engr., vol. 32, no. 7, July 1928, pp. 315–316. How number of hydroelectric plants are warding off ice troubles quite effectively by means of electric heating systems installed by Siemens-Schuckert-Werke; at Gratwein paper mill transformer of 95-kva. capacity and output voltage of 110 is employed for screenheating system.

Water Flow. Water-Flow Prediction for Hydraulic Power Stations (Wassermengenvorhersage im Kraftwerksbetrieb), A. Kvetensky. Elektrotechnik u. Maschinenbau (Vienna), vol. 46, no. 17, Apr. 22, 1928, pp. 375–377, 2 figs. After account of important features of organization of prediction service, reference is made to use of analysis of past long-period records, using 35-year (Bruencker) and 11-year (sunspot) periods, and estimating future effect of residuals when waves due to these have been found.

POWER PLANTS, STEAM

High-Pressure. Economies of Higher Pressures Substantiated. Power Plant Eng., vol. 32, no. 17, Sept. 1, 1928, pp. 918–919, 1 fig. Economy data from 10 representative high-pressure and temperature power plants has shown realization of theoretical gains from higher steam pressures and temperatures; heat consumption rates of these stations, as shown in table, are supported by detailed data comparing actual with calculated results and are ultimate proof of value of extended steam conditions; higher pressures do not cause lower turbine efficiency.

Waste Elimination in. How the Operating Engineer Can Stop Waste, D. M. Myer. Power, vol. 68, no. 10, Sept. 4, 1928, pp. 391–392. Author suggests plant for systematically surveying plant conditions; suggestion index for steam generation and for distribution and use of steam and energy.

POWER PLANTS, STEAM-ELECTRIC

Detroit. What Is in Detroit's Morrell Street Plan—and What It Cost. Power, vol. 68, no. 10, Sept. 4, 1928, pp. 402–404, 2 figs. Plant is arranged in units, each functioning as separate power plant in itself; one plant unit consists of one 25,000-kva. turbine-generator, with condenser, boiler-feed pumps, two boilers, transformer and electrical equipment; power is generated at 13,200 volts, three-phase, 60 cycles, and is then stepped up through auto-transformer to 24,000 volts for distribution via underground cables.

One-Man Operation. One-Man Operation for Avon Park Station, R. D. Stauffer and J. P. Garvin. Elec. World, vol. 92, no. 8, Aug. 25, 1928, pp. 349–357, 8 figs. Station was designed to be single plant with one-man operation; features of interest include centralized control of plant on one floor, arrangements to permit visibility of essential controls and apparatus from one operating position, no walls between boilers and turbo-generators and arrangements to burn either oil or pulverized fuel; use of automatic equipment to reduce labor cost and improve reliability.

Paris. Gennevilliers Power Station Expansion, M. Hentsch. Power Plant Eng., vol. 32, no. 17, Sept. 1, 1928, pp. 920–921, 2 figs. Two 50,000-kw. units at 415 lb. and 770 deg. fahr. added to use pulverized coal, stage heating, and air preheating; turbines are rated at 360 lb. pressure, 710 deg. fahr., and 96.5 per cent vacuum, 1500 r.p.m.; current is stepped up to 60,000 volt by single-phase, oil-cooled transformers.

PRESSURE VESSELS

Fusion Welding. Fusion Welds on Heavy Plate, R. W. Miller. Iron Age, vol. 122, no. 10, Sept. 6, 1928, pp. 567–570, 6 figs. Oxyacetylene and arc welding do not compete, but supplement each other, according to Swiss manufacturer's experience; when finished work must be uniform throughout he prefers oxyacetylene welding, believing that properties of weld material then correspond closely to those of plate; welders, joints, and completed work tests continuously in shops of Sulzer Brothers, Winterthur; types of welding equipment installed.

Welded Joints. Maximum Allowable Unit Working Stresses for Fusion-Welded Joints. Acetylene Jl., vol. 30, no. 2, Aug. 1928, pp. 70–71. Studies under way in cooperation with American Welding Society; proposed method of evaluating welded joint on basis of tests made of representative specimens submitted; formula which gives credit to ductility factor in welded joint.

PRODUCTION CONTROL

Continuous Flow. Working Equipment for Continuous Process Production (Vorrichtungen in der Fliessarbeit), G. Oehler. Maschinenbau (Berlin), vol. 7, no. 16, Aug. 16, 1928, pp. 770–774, 11 figs. Construction details of special adjustable revolving jigs increasing efficiency of workers.

Economic Quantities. Lower Cost by Economic Lot Sizes, P. N. Lehoczky. Mfg. Industries, vol. 16, no. 4, Aug. 1928, pp. 299–300, 1 fig. Development of simple formula for calculating most economic size of lot; particularly applicable to small jobbing shop, forge shop, or foundry; overcomes objections to more complicated scientific formulas.

PUMPS, CENTRIFUGAL

Design. Some Unusual Pumping Services, W. A. T. Gilmour. Can. Engr. (Ontario), vol. 55, no. 7, Aug. 14, 1928, pp. 225–226, 5 figs. Design of centrifugal pumps for sewerage, drainage, dredging, abattoir, quarry, dairy, salt manufacture, and other special purposes.

Fluids Other Than Water. Characteristic Laws for a Centrifugal Pump With Fluids Other Than Water, H. Mawson. Instn. Mech. Engrs.—Proc. (Lond.), no. 4, 1927, pp. 1037–1045, 5 figs. Comparison of centrifugal pumps with different fluids to determine relation connecting their resistances and speeds; apparatus erected at Univ. of Liverpool; motor acting as transmission dynamometers; three types of characteristics, one agreeing with those for water, one for small deliveries with fluids of high viscosity, and another with larger deliveries and viscosities, unstable region occurring between latter types.

Petroleum Pipe Lines. Big Development in Centrifugal Pumps, A. H. Borchardt. Oil and Gas Jl., vol. 27, no. 15, Aug. 30, 1928, p. T-176, 2 figs. Research work has resulted in widespread use of this type of machinery in pumping of crude oil.

Piping. Centrifugal Pumps, E. W. Sargeant. Mech. World (Lond.), vol. 84, nos. 2167 and 2171, July 13 and Aug. 10, 1928, pp. 28–29 and 124–126, 9 figs. July 13: Design of piping and valves for centrifugal pumps; if desired to keep percentage of frictional loss down, pipes must be larger when pump is operating on high head than when on low head; pump works at best efficiency with little or no suction and it is always better to have long delivery than long suction. Aug. 10: Gratings on suction pipes; pipe friction; belt and rope drive; drive by steam engine, internal-combustion engine, electric motor, and steam turbine.

PUMPS, ROTARY

Multi-Disk. The Hollko Multi-disk Rotary Pump (Die Hollko Waelzkolbenpumpe) Jentsch. V.D.I. Zeit. (Berlin), vol. 72, no. 33, Aug. 18, 1928, pp. 1158–1160, 13 figs. Construction details of new type of rotary pump (Mocigemba design) consisting of two shafts carrying six rotary disks each, manufactured by Hollunder and Co. of Essen for heads of 50 to 200 m. and up to 1900 r.p.m.; tests by author at Duisburg School of Mechanical and Mining Engineering ndicate efficiency of 35 per cent.

R

RAILWAY MOTOR CARS

Gasoline-Electric. A Solution of the Branch Line Problem, L. C. Paul. Ry. and Locomotive Eng., vol. 41, no. 6, June 1928, pp. 155–158, 2 figs. Steam equipment which has become obsolete on main line has been relegated to branch where it is continued in service at exorbitant cost for maintenance and unwarranted expense for operation; on branch line of one railroad, deficit of $36,000 was changed into profit of $102,000, by substituting gasoline-electric rail cars for steam trains.

REFRIGERATION

Research Laboratories. The New Refrigeration of the German Institute of Engineering Physics (Das neue Kaeltelaboratorium der Physikalisch Technischen Reichsanstalt), W. Meissner. V.D.I. Zeit. (Berlin), vol. 72, no. 31, Aug. 4, 1928, pp. 1069–1076, 9 figs. Financing of new laboratory of government institute; general plan of buildings and general equipment; details of special apparatus for liquefaction of nitrogen (20 liters per hour) oxygen (7 l/hr.), hydrogen (10 l/hr.) and helium (2.5 l/hr.); apparatus for separation of neon from helium and for purification of helium.

RESINS

Synthetic, Properties of. Elasticity and Mechanical Properties of Resinoids as a Function of Their Preparation, O. Manfred and J. Obrist. Plastics, vol. 4, no. 7, July 1928, pp. 371–372 and 374, 1 fig. Theory as to effect of mechanical working upon physical properties of pheno-plastics; variation in strength of different portions of single block or rod.

ROCKETS

Laws of Flight. Mechanics of Interplanetary Rockets (Zur Mechanik der Weltraumraketen), H. A. Senftleben. Zeit. fuer Flugtechnik u. Motorluftschiffahrt (Munich), vol. 19, no. 14, July 1928, pp. 319–323, 4 figs. Mathematical discussion of laws of flight of rockets through air, with minimum consumption of working substance.

Rocket Engines. The Problem of Rocket Vehicles (Zur Frage der Raketenfahrzeuge), R. Conrad. Motorwagen (Berlin), vol. 31, no. 19, July 10, 1928, pp. 440–441. Discussion of principles of rocket propulsion; patentability of rocket vehicles; ancient and comparatively recent applications of rocket principle of propulsion; efficiency of rocket engines is low except at very high speeds; use of compressed hydrogen and oxygen in rocket engines; limited practical possibilities.

The Rocket Engine and Its Prospects (Der Raketenmotor und seine Aussichten), K. Baetz. Schweizerische Bauzeitung (Zurich), vol. 92, no. 8, Aug. 25, 1928, pp. 98–99, 3 figs. Theoretical principles and construction of rocket engines with particular reference to engine invented by author, which is driven by gasoline explosions, and which for same weight of explosive is 100 times more powerful than one driven with dynamite.

ROLLING MILLS

Germany. Plating and Rolling Mill Planned in Germany. Iron Trade Rev., vol. 83, no. 9, Aug. 30, 1928, p. 505. Brief note on new plating plant and rolling mill being constructed by Eisen and Stahlwerke Actiengesellschaft of Dortmund, on its property in Ruhr; it is planned to roll aluminum, and later other metals, on ordinary black steel sheets by special, patented process.

Motor Control. Scherbius System for Regulation of Speed of Motors in Rolling Mills (Système "Scherbius" pour le réglage de la vitesse des moteurs de laminoirs), J. Froidevaux and P. Pelissier. Electricité et Mécanique (Paris), no. 24, May-June 1928, pp. 27–37, 11 figs. Description of modern installation in metallurgical works at Mondeville, France; uses d.c. 3-phase for operating non-reversible train of rolls; operation of Scherbius system; speed regulation.

S

SEAPLANES

Biplane. The Short "Calcutta" All-Metal Flying Boat. Engineering (Lond.), vol. 126, no. 3266, Aug. 17, 1928, pp. 195–200, 73 figs., supp. plates. This is believed to be first all-metal flying boat of British design to be completed for commercial work; span of upper main plane, 93 ft.; span of lower main plane, 76 ft. 6 in.; weight of machine empty, 12,404 lb.; load carried, 7596 lb., including 15 passengers and crew of three; three engines are mounted in separate nacelles attached to wing spar by three radial struts at each end.

SOLDERS

Properties. The Strength of a Cadmium-Zinc and of a Tin-Lead Alloy Solder, C. H. M. Jenkins. Inst. Metals—advance paper (Lond.), no. 479, for mtg. Sept. 4–7, 1928, 19 pp., 11 figs. Comparison is made of relative strengths in direct tension of cadmium-zinc and tin-lead solder under both rapid and prolonged tests conducted at room temperatures and at 120 deg. cent.; marked differences between strengths of cast, rolled, aged, and heat-treatment material were observed; cadmium-zinc alloy shows markedly higher values; its tensile strength is approximately four times that of tin-lead solder.

STEAM

High-Pressure, Utilization of. High-Pressure Steam; Opportunity for Its Use in Industry (La vapeur à haute pression), V. Kammerer. Société Industrielle de Mulhouse—Bul. (Mulhouse), vol. 94, no. 6, June-Aug. 1928, pp. 385–432, 15 figs. Properties of water at high pressures; particulars of high-pressure generators of various forms and types; theoretical advantages of using high pressures for producing motive power; specific consumption of fuel, combining motive power and heating pressure and price of installations, selection of best pressure; examples.

High-Pressure Steam Usage, C. S. Darling. Mech. World (Lond.), vol. 84, no. 2168, July 20, 1928, pp. 52–53, 2 figs. Conditions necessary for maximum economy in power generation are discussed; how plant extension may be economically affected by addition of primary turbines; high initial pressure develops use of back-pressure systems; gain due to increased heat drop; overall efficiency more important than individual unit efficiency; cost of plant is limiting factor; economy possible with simpler plant. (To be continued.)

STEAM CONDENSERS

Tubes, Corrosion of. The Corrosion of Condenser Tubes. "Impingement Attack;" Its Causes, and Some Methods of Prevention, R. May. Inst. of Metals—advance paper (Lond.), no. 471, for mtg. Sept. 4–7, 1928, 35 pp., 8 figs.

Report on investigations of impingement attack undertaken in order to interpret results of certain tests on condenser tubes, and to explain relationship between effects of intermittent cavitation in water, and of air-bubble impingement; experimental work shows that, when there is no intermittent cavitation, impingement attack can still take place as result of air-bubble impingement.

STEAM ENGINES

Vibration Prevention in. Stopping Building Vibrations Due to Unbalanced Engines, C. H. Bigelow. Power, vol. 68, no. 11, Sept. 11, 1928, pp. 450–451, 2 figs. Author describes method employed to stop vibration in large power plant which, when completed, swayed on its foundation so violently that provision had to be made to stop motion; engines were cross-compound horizontal units each of 1800 nominal hp.; large counterweights, part of them weighing 590 lb. each and part 530 lb., were made in two parts, so that they could be bolted around spokes near rim of flywheel; these weights remained on engines for several years.

STEAM PIPE LINES

Flexibility. The Flexibility of Plain Pipes, J. R. Finniecome. Engineer (Lond.), vol. 146, nos. 3788 and 3789, Aug. 17 and 24, 1928, pp. 162–165 and 199–200, 16 figs. Series of articles dealing with flexibility of pipes as related to temperature changes and thrust. Aug. 17: Method of determining flexibility of any pipe bend. Aug. 24: Comparison of theoretical values with actual test figures; tests by Crane Co., United States.

STEAM TURBINES

Blades. Detailed Numerical Calculation of Multiple-Action Blading (Calcul numerique détaillé d'un ailettage multiple à action), C. Colombi. Technique Moderne (Paris), vol. 20, no. 15, Aug. 1, 1928, pp. 519–525, 7 figs. New simple method for calculating blades and some applications especially in preliminary work; high and low pressure; predetermination of blading for 15,000-hp., 3000-r.p.m. turbine.

Turbine Blading Problems, S. M. Robinson. Am. Soc. Naval Engrs.—Jl., vol. 40, no. 2, May 1928, pp. 223–228, figs. on supp. plates. During past year, at Puget Sound Navy Yard, number of turbines have been rebladed and it is believed that methods used for this work may prove interesting to shipbuilding world generally as well as to naval service.

Design. The General Trend of Modern Development in Steam-Turbine Practice, H. L. Guy. Power, vol. 68, no. 6, Aug. 7, 1928, pp. 250–251, 2 figs. Author presents results of important studies and sets forth British point of view. Paper presented before Instn. Civil Engrs., previously indexed.

Exhaust. Brown Boveri Combined Reciprocating Engine and Turbine Drive. Mar. Eng. and Shipg. Age. vol. 32, no. 8, Aug. 1928, pp. 437–441, 3 figs. Development and advantages of plants in which a reciprocating engine and exhaust-steam turbine are combined are briefly considered; description of design and working of exhaust-steam turbine plants which Brown Boveri & Co. are building for two cargo vessels ordered by North German Lloyd.

Ruths. The Ruths Turbine (Ruthsturbinen), C. Foehl. Archiv fuer Waermewirtschaft (Berlin), vol. 9, no. 8, Aug. 1928, pp. 243–248, 19 figs. Description of new type of turbine known as Ruths accumulator turbine for use with Ruths steam accumulator; notes on absorption capacity; pressure in turbine and steam consumption; characteristic diagram; determination of average steam consumption with given load curve; performance and characteristic curve of turbine for live and stored steam.

Testing. Steam-Combustion Tests of Three-Cylinder 16,000-Kw. Brown Boveri Steam Turbine in Rotterdam (Dampfverbrauchs-Messungen an einer dreigehaeusigen 16,000 kw. Brown Boveri Dampf-Turbine in Rotterdam), D. Dresden. Schweizerische Bauzeitung (Zurich), vol. 92, no. 5, Aug. 4, 1928, pp. 57–59, 2 figs. Descriptive and test data on 16,000-kw., 3000-r.p.m., 12-atmos. pressure, Brown Boveri, two-stage turbine of Schiaven power plant of Rotterdam municipal electric system; steam consumption 4.50 to 4.88 kg. per kw-hr.

STEEL

Cold Drawing. Study of Cold Drawing of Soft Steel (Contribution à l'étude de l'étirage à froid de l'acier doux), R. Giraud. Revue de Métallurgie (Paris), vol. 25, no. 6, June 1928, pp. 347–354, 4 figs. Measure of work absorbed by metal under form of potential energy; method of testing and table of tests with results of cold drawing.

Heat Treatment of. Facts and Principles Concerning Steel and Heat Treatment, H. B. Knowlton. Am. Soc. Steel Treating—Trans., vol. 14, no. 3, Sept. 1928, pp. 415–434. First of series of articles on heat-treating equipment and methods. Among subjects discussed are: fundamental requirements of heating equipment, pyrometers, simple box-type furnaces, coal, oil gas, and electric heating.

Heating of Steel by the Controlled Temperature Method, G. W. Hegel. Am. Soc. Steel Treating—Trans., vol. 14, no. 3, Sept. 1928, pp. 377–384, 7 figs. Author demonstrates effect of rate of heating through critical range on temperature distribution in piecc of steel; he shows how best results can be obtained by controlling maximum temperature.

Manganese. See MANGANESE STEEL.

Spring, Testing. Researches on Springs—Torsional Fatigue Tests on Spring Steels, G. A. Hankins. Dept. of Sci. and Indus. Research—Eng. Research (Lond.), Special Report No. 9, 1928, 24 pp., 8 figs. partly on supp. plates. Investigation by National Physical Laboratory as part of systematic study undertaken by Springs Research Committee; tests devised to disclose actual properties under torsional stress cycles similar to those under working conditions; variations due to surface blemish, decarburization and other disturbing factors eliminated; results given in full with discussion.

Structural Arc Welding. Arc Welding of Structural Steel (Lichtbogenschweissung von Eisenkonstruktionen), K. Bung. V.D.I. Zeit. (Berlin), vol. 72, no. 32, Aug. 11, 1928, pp. 1105–1111, 54 figs. Report from committee on Welding, of Verein Deutscher Ingenieure, on details of welded seams and joints and methods of making them; tensile tests of welded seams and joints; tests of comparative strength of welded and riveted joints; arc welding of pipes, tubes and structural shapes; practical examples of welded steel trusses, tanks, etc., cost data.

Tool. See TOOL STEEL.

STEEL CASTINGS

Alloy-Steel. Steel Castings Withstand Severe Operating Conditions, J. H. Hall. Foundry, vol. 56, nos. 16 and 17, Aug. 15, and Sept. 1, 1928, pp. 655–656 and 702–704. Aug. 15: So far as author is aware, no steel or iron yet has been found that will resist pure abrasive wear unaccompanied by pressure as satisfactorily as manganese steel; uses of nickel-chrome steels; greatest advance made in field of heat-treated castings of high strength and toughness for resisting heavy stresses. Increase of physical properties by use of additional alloys to special steels; work in high-temperature field.

T

TEMPERATURE MEASUREMENT

Thermoelectric. Thermoelectric Measurement of Temperatures Above 1500 Deg. Cent., H. L. Watson and H. Abrams. Am. Electrochem. Soc.—Advance Paper, for mtg Sept. 20–22, 1928, pp. 29–41, 6 figs. After brief discussion of standard methods of temperature measurement from (1832 to 3632 deg. fahr.), account is given of tungsten-graphite thermocouple, including its construction, characteristics, and application.

TEXTILES

Sizing Materials. Tests on Ash, Grit, Color, Pasting Points, and Lasting Qualities of Starch, A. H. Grimshaw. Textile World, vol. 74, no. 6, Aug. 11, 1928, pp. 40 and 43. Article deals with results obtained from tests on ash, grit, color, pasting points, and lasting qualities; tables show results in comparative way; ash-determination methods.

TIDAL POWER

Utilization. Tidal Power and Turbines Suitable for its Utilization, A. H. Gibson. Water and Water Eng. (Lond.), vol. 30, no. 356, Aug. 20, 1928, pp. 374–375. Most important problem is that of storage; best size and type of turbine setting for use in tidal scheme; mean head would be 14 ft., while maximum and minimum working heads would be 22.5 and 7.5 ft.; possible, with efficient setting, to install turbines of 10 ft. diam., which will develop 60 b.hp. per linear foot of barrage under head of 14 ft. Abstract of paper read before Instn. Mech. Engrs., previously indexed.

TIME STUDY

Machine Shops. Time Studies in Plant Manufacturing a Variety of Machines. Machy. (Lond.), vol. 32, no. 825, Aug. 2, 1928, pp. 570–571. Time-study analyses in plant manufacturing great number of different parts in small quantities; greater savings in cost are possible by studying individual machine parts, using assembly as guide when questions of tolerance and finish are brought up; grouping part for time study charts listing grouped parts; preparation for time setting; classification of machines and work; rules for setting rates; improvement suggested by foreman; working instructions for shop.

Metal-Working Plants. Time Studies in Metallurgical Plants (Zeitstudien auf Huettenwerken), K. Rummel. V.D.I. Zeit. (Berlin), vol. 72, no. 34, Aug. 25, 1928, pp. 1183–1188, 8 figs. Role of time study in rationalization processes, engineering methods of industrial-management research; analysis of manual labor and work processes; cost analysis; special charts and nomograms; examples from practice of modern wire mills, blast-furnace plants, foundries, and other plants.

TOLERANCES

Selection. Selecting the Tolerances, J. F. Hardecker. Am. Mach., vol. 69, no. 9, Aug. 30, 1928, p. 341. Entire successful functioning of elaborate mechanism may rest upon successful choice of tolerances; in most instance, tolerances have to go through a period of development design similar to that which idea itself had to go through before it became proved idea.

TOOL STEEL

Properties. On the Nature and Applications of the Principal Types of Tool Steel, W. H. Wills. Am. Soc. Steel Treating—Trans., vol. 14, no. 3, Sept. 1928, pp. 363–376, 2 figs. There are now on market hundreds of brands of tool steel; these brands may be largely divided into five types, carbon and carbon-vanadium, oil-hardening, high-carbon, low-tungsten, hot die, and high-speed steels; it is purpose of this paper to discuss from practical standpoint structure and physical properties of each type of steel.

Widia. Widia Tool Steel. Automobile Engr. (Lond.), vol. 18, no. 244, Aug. 1928, p. 280. New Cutting metal which possesses remarkable properties is described; Widia tool steel has degree of hardness surpassing anything previously attained; made by patented process, principal constituents being tungsten carbide with some cobalt and traces of manganese.

TRAIN CONTROL

Automatic. Methods Used in Finding Defects in Train Control Equipment, G. R. Brown. Ry. Elec. Engr., vol. 19, no. 8, Aug. 1928, pp. 256–258, 1 fig. Simplified outline aids in running down faults in continuous automatic stop system with least expenditure of time and trouble; defects liable to occur in U. S. & S. electric and pneumatic equipment used on Hartford division of New York, New Haven and Hartford Railroad; applying remedy.

Auto-Manual Train Stops. Intermittent Inductive Auto-Manual Train Stop, H. S. Walton, Am. Soc. Mech Engrs.—Advance Paper, for mtg. Oct. 1–3, 1928, 2 pp., 1 fig. Brief explanation of purpose and operation of automatic signal and track circuits; description of system of train stop which is so designed that if generator stops; wire is broken, or other disorders occur, brake is automatically applied; as evidence of extent to which automatic train control has been installed, it is now possible to board train at Boston and ride to Chicago under protection of intermittent inductive auto-manual train shop.

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WELDED JOINTS

Effect of Shape on Strength. Influence of the Shape of Ends of Parts of Certain Welded Joints on the Value of Breaking Load and Deformation (Influence de la forme des abouts des éléments de certains assemblages soudes sur la valeur de la charge de rupture et sur la déformation), D. Lagrange and D. Rosenthal. Académie des Sciences—Comptes Rendus (Paris), vol. 187, no. 5, July 30, 1928, pp. 277–279, 1 fig. Discussion of effect of butt-joint ends on strength of joint. See also Génie Civil, vol. 93, no. 7, Aug. 18, 1928, p. 171, 2 figs.

WELDING

Electric. See ELECTRIC WELDING.

Oxyacetylene. See FOUNDRY PRACTICE.

WOODWORKING PLANTS

Management. How Management Costs Were Cut 50 Per Cent, E. F. Werner. Indus. Woodworking, vol. 28, no. 11, Aug. 1928, pp. 9–13, 1 fig. Account of complete reorganization of woodworking plant resulting in 50 per cent reduction in costs.